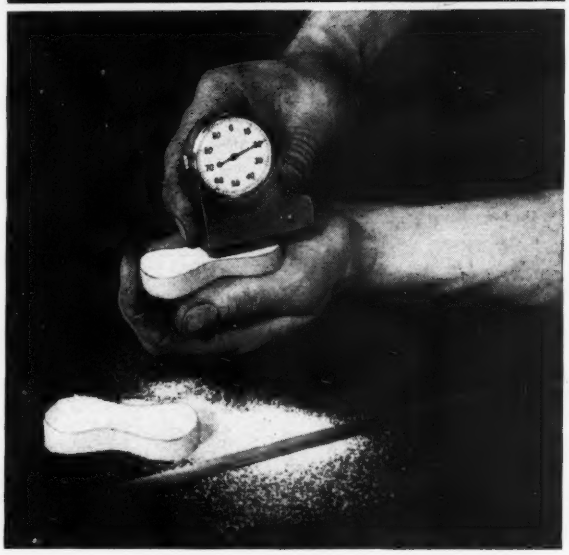
American Foundryman

AMERICAN FOUNDRYMEN'S ASSOCIATION
FOUNDED 1896

It's still the newest news for foundries



AQUA·SET

CORE BINDER

The miracle bond of tomorrow can be had today; it is the answer to problem jobs in the core room. AQUA-SET, a synthetic core binder, produces cores which show the following qualities: (a) harder surface; (b) softer center; (c) a thorough bake at 350° F.; (d) a faster bake at 400° F.; (e) half normal gas content; (f) a fast collapse on pouring; (g) cleaner castings; (h) smoother castings; (i) all metal adaptability.

Cores made with AQUA-SET can be processed to suit your needs. A surface hardness of 96 or better can be developed with center hardness ranging from this point down to 20 or below. Dietert's hardness tester was used on the tensile core shown above, which indicates a surface hardness of 96 and a center hardness of 20 after the same core had been cut in half with a hack saw blade.

UNITED

United Oil Manufacturing Co.

1492 WALNUT ST., ERIE, PA.

American Foundryman

JULY 1945

VOLUME VII
Number 7

Page

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WHO ARE THE AUTHORS *In This Issue?*

The men whose names are shown on these two pages deserve the thanks of the industry for their contributions to the 1945 "Year-'Round Foundry Congress" . . . in many cases, completed in spite of cancellation of the Detroit convention.

Harry Reitinger

Author of paper herein on *"Sound Wage Incentives"* . . . A native of Philadelphia, educated in the schools of that city . . . His first position was consulting engineer with the Pure Water Apparatus Co. . . . Became associated with Emerson Efficiency Engineers, New York . . . As a consultant for the Government, installed distilling plants at various fortifications . . . During World War I, retained by the Government in the manufacture of munitions, in both U. S. and Canada . . . Returned to Emerson Engineers following the war . . . In 1922, began a long association with United States Pipe & Foundry Co. . . . Appointed Resident Manager at Burlington, N. J., plant . . . In 1943, became connected with Bethlehem Steel Co., Bethlehem, Pa. . . . Rejoined Emerson Engineers a year later . . . A National Director of A.F.A. and a past chairman of Philadelphia Chapter.

Luther A. Kleber

Author (with associate H. W. Meyer) of current paper on *"Molding Sand Properties at Elevated Temperatures"* . . . Following elementary schooling and university extension work, joined Taylor-Wharton Iron & Steel Co., Easton, Pa., in 1915. . . . Saw service in U. S. Army during World War I, then rejoined Taylor-Wharton in 1919 . . . Over a period of nine years held successive positions as cleaning room supervisor, assistant foundry superintendent and superintendent of foundry, pattern shop and cleaning room . . . Transferred to High Bridge, N. J., plant in 1928 . . . There progressed from assistant foundry superintendent, to foundry superintendent, to foundry manager, over a 12-year-period . . . Recently became assistant foundry superintendent, Commonwealth plant, General Steel Castings Corp., Granite City, Ill. Has contributed to many A.F.A. chapter programs, speaking on synthetic molding sands . . . Director and past chairman of St. Louis District Chapter, and past director of Metropolitan Chapter.

H. W. Lownie. Jr.

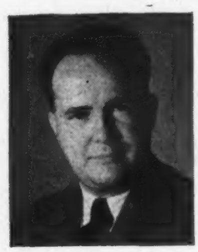
One of the youngest A.F.A. contributors, and author of an interesting paper herein on *"Theories of Gray Cast Iron Inoculation"* . . . Born in Buffalo, N. Y., 27 years ago . . . Matriculated at Purdue University, Lafayette, Ind., and was graduated in 1939 with a B.S. in chemical engineering . . . Appointed foundry control engineer, Westinghouse Electric Corp., East Pittsburgh, Pa. . . . Obtained a Master of Science degree in metallurgical engineering from the University of Pittsburgh Evening School in 1943 . . . That same year, was appointed materials engineer at Westinghouse . . . Today holds position of metallurgical engineer . . . Contributed papers to 1944 A.F.A. Foundry Congress and to the 1945 Symposium on Inoculation of Gray Iron . . . Assisted in 1944 revisions of A.F.A. Cast Metals Handbook and Alloy Cast Irons Handbook . . . Member of A.F.A. Committee on Inoculation . . . Holds membership in A.F.A. and A.S.M.

A. C. Kalk

See his interesting article herein on *"Photo Position Finding"* . . . A native of South Bend, Ind. . . . His father, John F. Kalk, was a foundry executive of the former Montague Castings Co., Montague, Mich. . . . The author received his foundry training from his father at the Montague plant . . . Spent two years at Lakey Foundry & Machine Co., Muskegon, Mich., in a supervisory capacity . . . Has since been associated with the Continental Motors Co., Automotive Plant, Muskegon, Mich. . . . Now holds the position of Assistant Chief Inspector . . . Member of A.F.A. and S.A.E.

Robert C. Cornell

Metallurgist for Dow Chemical Co., Midland, Mich. . . . Co-author, with associate C. E. Nelson, of magnesium paper in this issue . . . See: *"Principles of Die Casting Magnesium Alloys"* . . . Mr. Cornell was born in Cleveland, May 1915 . . . Earned his Bachelor of Science degree in metallurgy at Fenn College, Cleveland, (1939) . . . Gained considerable metallurgical experience in local plants while attending college on a cooperative basis . . . Upon graduating, served an apprenticeship at Republic Steel Corp., Cleveland, 1939-40 . . . Cleveland Graphite Bronze Co., Cleveland, engaged him as metallurgist in 1940 . . . Present connection with Dow began in 1941 . . . An A.F.A. member.



Charles E. Nelson

See: *"Principles of Die Casting Magnesium Alloys"* . . . Co-author, R. C. Cornell . . . Mr. Nelson was born in Nelsonville, Ohio, in 1907 . . . Following elementary schooling, he received his degree from Alma College, Alma, Mich., in 1928 . . . That same year, joined Chevrolet Motor Co., Flint, Mich., as metallurgist . . . The following year, accepted position of re-

search chemist at E. I. Du Pont de Nemours Co., Wilmington, Dela. . . . In 1930, became affiliated with Dow Chemical Co., Midland, Mich. . . . Appointed metallurgist, he has since been made assistant director of metallurgical research (1942) . . . Has written extensively for the trade press on such magnesium subjects as melting, die casting, refining, heat treatment, and corrosion . . . Papers also presented before A.S.M., A.I.M.E., and A.F.A. meetings . . . Member of A.I.M.E., A.S.M., American Chemical Society, and A.F.A.

H. M. Hazeltine

Author of, in this issue, *"Special Brick Shapes for Cupola Refractories"* . . . Born in Logansport, Ind. . . . First foundry connection in 1914 with Dodge Bros., Detroit, as foundry foreman . . . Moved to Canton, Ohio, in 1917 as cupola foreman with Henry-Miller Foundry Co. . . . Three years later, accepted similar position with Fremont Foundry Co., Fremont, Ohio . . . In 1926, joined McWane Cast Iron Pipe Co., Birmingham, Ala. . . . Returned to Fremont Foundry in 1929 in charge of cupola operations, which position he holds today . . . Has written several practical papers for the Gray Iron Research Institute, of which he is a member.

Norman J. Dunbeck

Vice-president, Eastern Clay Products, Inc., Eifort, Ohio . . . Author of non-ferrous sand paper in this issue on *"Synthetic Sand in Non-Ferrous Foundries"* . . . Born in Lancaster, N. Y., May 1902 . . . Received his Bachelor of Science degree from Catholic University of America, Washington, D. C., in 1924 . . . Began his business career with Donner Steel Co., Buffalo, N. Y. . . . A year later (1925) appointed Foundry Engineer, Symington-Gould Corp., Rochester, N. Y. . . . In 1926 became affiliated with Eastern Clay Products, Inc., in order to establish their first laboratory . . . Named eastern plant manager in 1927 . . . From 1928 to 1931, served as sales engineer . . . Became production manager in 1931 . . . Assumed his present title a few years ago . . . An active member of A.F.A., has presented many papers dealing with sand at annual Foundry Conventions . . . Member of executive and other committees of A.F.A. Foundry Sand Research Project.

Henry W. Meyer

Co-author (with L. A. Kleber) of *"Molding Sand Properties at Elevated Temperatures"* . . . Born in California, Mo. . . . Earned his Bachelor of Science degree in ceramic engineering at Missouri School of Mines and Metallurgy, Rolla, Mo., 1932 . . . Upon graduating, joined General Refractories Co., Clayton, Mo., in research and control work . . . Became connected with General Steel Castings Co., Commonwealth plant, Granite City, Ill., in 1939 . . . Assigned to sand processing and research . . . Has written for A.F.A. and Steel Founders' Society of America . . . Subjects include dilatometer testing and sand behavior at elevated temperatures . . . Member of A.F.A.

C. W. Stephens

Co-author (with E. L. La Grelius) of a 2-part paper on *"Steel Castings Radiography"* . . . First part can be found in the May AMERICAN FOUNDRYMAN . . . Born in the "Garden State" of New Jersey . . . Became affiliated with the foundry industry in 1940 when he joined American Steel Foundries . . . At the Granite City Works, Granite City, Ill., he showed keen interest in radiography . . . Appointed foreman of the x-ray department at Granite City in 1942.

E. L. La Grelius

See, in this issue, *"Steel Castings Radiography — Part 2"* . . . First section published in May, 1945, issue . . . Co-author is C. W. Stephens . . . Mr. La Grelius was born in Illinois . . . Now Supervising Metallurgist, American Steel Foundries, East Chicago, Ind. . . . Associated with American Steel for the past four years in metallurgical capacity . . . Author of several papers on radiography and chemistry subjects . . . Member of A.F.A.

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Cooper-Bessemer says...

Hydro-Blast room at Cooper-Bessemer, Grove City, Pa.

Panel board, motors and pumps are Simonized regularly.

A two-gun Hydro-Blast cleaning unit was installed at Grove City plant of the Cooper-Bessemer Corp. July 31, 1944. The daily production of 65 tons of castings is all cleaned the Hydro-Blast way during two 9-hour shifts. They also reclaim about 12 tons of sand and salvage 2 to 4 tons of coke per day out of their over-size skip box. This material is used to open up their core sand.

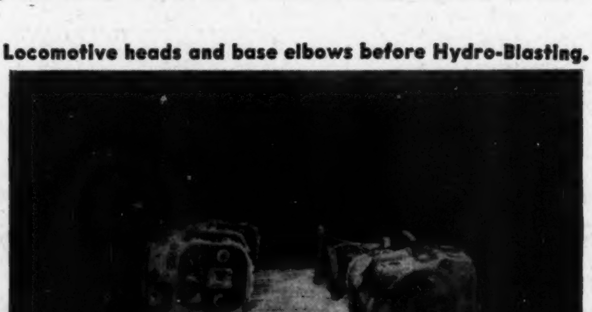
The total cost of the reclaim sand core mix is only 40% of the cost of a new sand core mix and these substantial savings are inherent with Hydro-Blast.

Cooper-Bessemer previously used Millville Gravel to make runner boxes. Now they use Hydro-Blast sand to make these runner boxes and the same man can now make five runner boxes out of Hydro-Blast sand in the time previously required to make one from Millville Gravel because Hydro-Blast sand has greatly simplified the ramming problem.

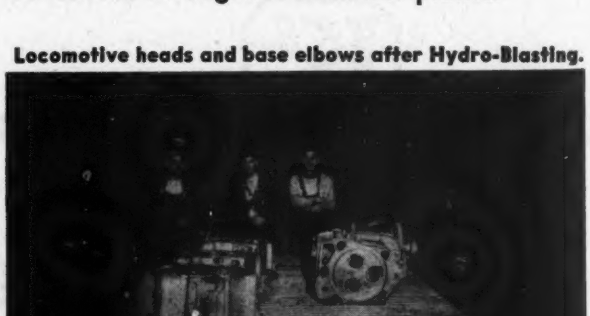
Sand recovered by Hydro-Blast at Cooper-Bessemer is superior to new sand in grain distribution. When received from the dewatering boxes, the moisture content is about 8½%. It is then deposited in leaching bins which reduce the moisture to 6-7½% which is just about right for use after bonding.

Says The Cooper-Bessemer News: "The Hydro-Blast represents one of our projects to facilitate and speed up production and improve working conditions throughout both our plants."

Locomotive heads and base elbows before Hydro-Blasting.



Locomotive heads and base elbows after Hydro-Blasting.



"HYDRO-BLAST is THE NEWEST AND MOST MODERN METHOD KNOWN FOR CLEANING CASTINGS"

Commercial heads (360 lbs. each) before Hydro-Blasting. Former blasting method required 25 minutes each.

Commercial heads after Hydro-Blasting which reduced cleaning time to 12 minutes each for a superior job.

2100 lb. press head, 44" dia., 26" high. Hydro-Blasted in 66⅔% less time.

Castings 24" x 12" x 17" = 470 lbs. are Hydro-Blasted in 8 minutes.

4080 lb. cylinder block Hydro-Blasted in 1¼ hours as opposed to 8 man hours.

Hydro-Blasted in 12 minutes as opposed to 25 minutes former cleaning time.

Hydro-Blast

2550 North Western Avenue

CHICAGO 47, ILLINOIS


Consider these Five Features
1
PROPER ADHERENCE
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EVERYTHING FOR A FOUNDRY
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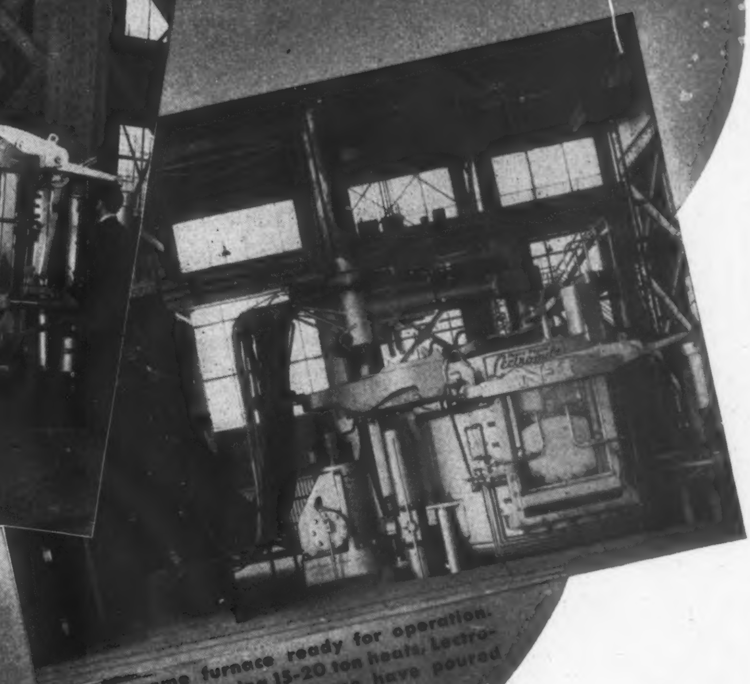
MOORE RAPID

Lectromelt

FURNACES

A size "NT" Lectromelt top-charge furnace, showing drop-bottom bucket in charging position.

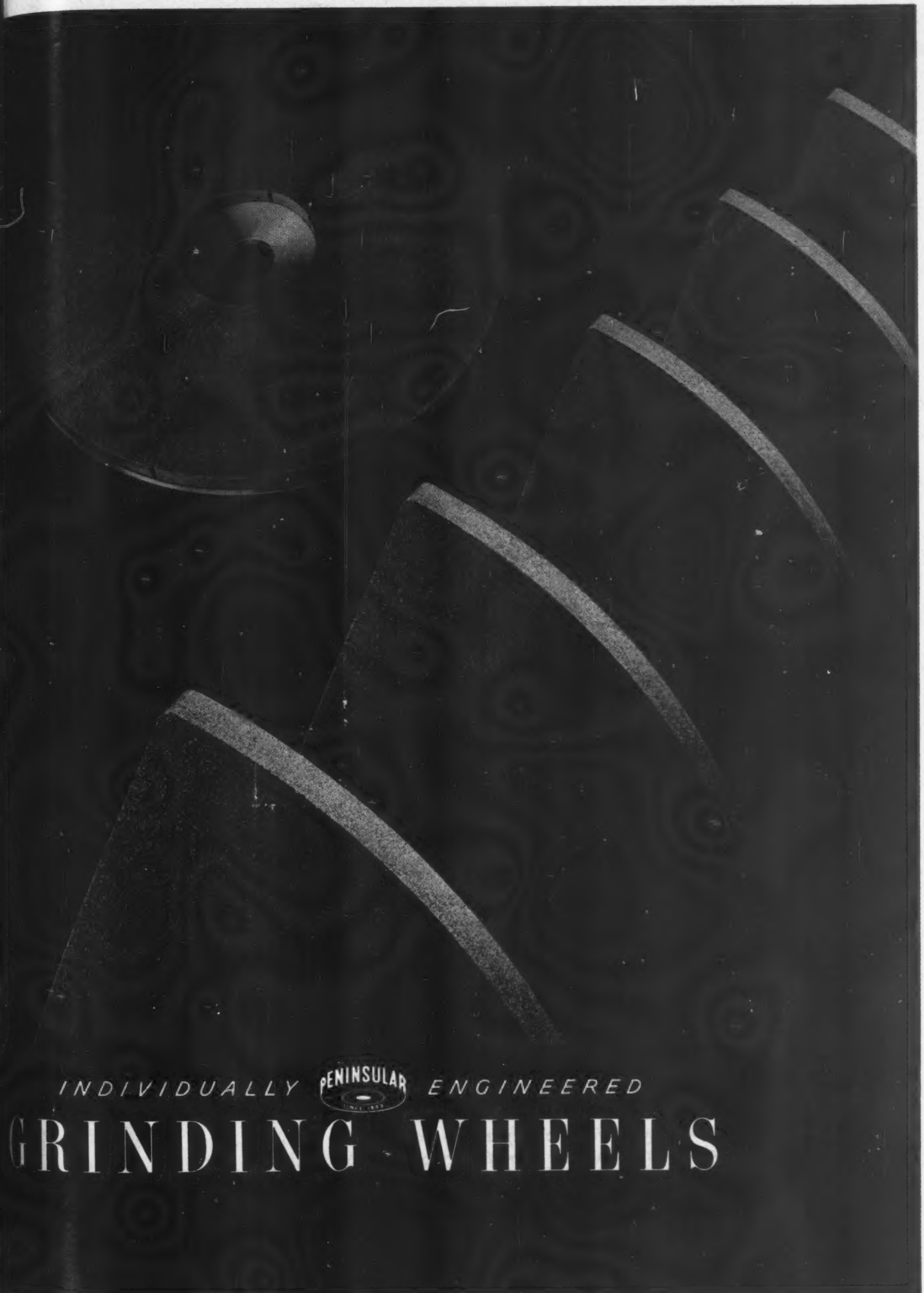


The same furnace ready for operation. Normally pouring 15-20 ton heats, Lectromelt furnaces of this type have poured double their rated capacities.

Moore Rapid Lectromelt furnaces are daily melting quality steels and irons in foundries and ingot shops throughout the world. They are available in capacities ranging from 100 tons down to 25 pounds.

PITTSBURGH LECTROMELT FURNACE CORPORATION

PITTSBURGH 30, PENNA.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GRINDING WHEELS

☆ ☆ *Nickel*

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Nickel also serves as a valuable tool within the foundry itself by alleviating such problems as porosity, shrinkage, chilled corners and edges and non-uniformity in castings of irregular section or unusual design.

Suitable forms of Nickel and Nickel alloys have been developed to simplify its use by both ferrous and non-ferrous foundrymen.

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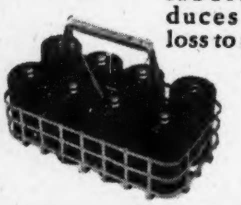
Our technical staff and the casting specialists of our distributors have had many years of experience with foundry problems. They will welcome the opportunity to cooperate with you.

THE INTERNATIONAL NICKEL COMPANY, INC. 67 WALL STREET NEW YORK 5, N. Y.

SAND RAMMER (*left*) standard for ramming specimens of molding sand and cores for the AFA green and dry permeability test and all standard strength tests.

SAMPLE TRAY (*below*) for transporting sand samples to laboratory. Reduces moisture loss to a minimum.

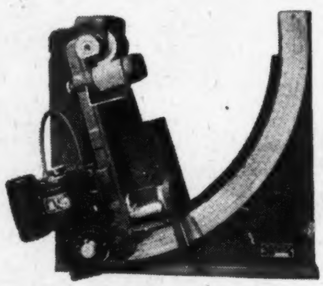


REDUCE SCRAP LOSSES

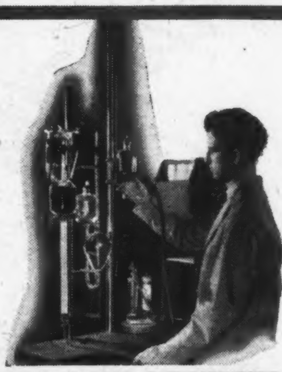
PREPARE YOUR FOUNDRY for postwar competition by installing a practical sand control program to *reduce scrap losses.* We are able to supply you with the equipment necessary to carry out this program. This can be accomplished with little effort and a surprisingly small investment. Write us describing your available sand preparing equipment, type and size of castings and tonnage. *We will be glad to give you our recommendations for a suitable sand control program.*

THE HITEMP DILATOMETER You can be sure of better castings by knowing how your sands behave at pouring temperatures. The Dilatometer makes available both the visual as well as the physical testing of all molding materials at temperatures and conditions which prevail in the mold at the time the metal is poured. Two models now available.

MOISTURE TELLER Will dry a fifty gram sample of high permeability molding sand in one minute by forcing electrically heated air through the test sample. Test is in exact moisture percentage by gravimetric method. No calibrations are required. *Operating cost is very low.*



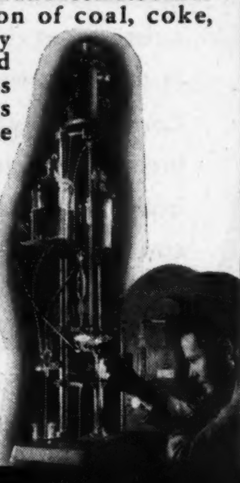
UNIVERSAL SAND STRENGTH MACHINE WITH MOTOR DRIVE . . . Performs a wide variety of strength tests on molding sands, clays, cores and core pastes. You can obtain accurate results with this sturdy and reliable unit with a minimum amount of personal attention.



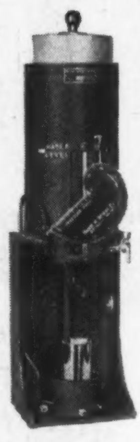
2-MINUTE CARBON DETERMINATOR enables you to determine either preliminary or final carbon content of all metals with speed and accuracy. Complete determination can be made *within 2 minutes* after sample is weighed.

TEST CORE BAKING OVEN . . . This sturdily constructed, electrically heated oven, bakes test cores or dry sand specimens entirely by convected heat. Ideal for determining the strength of core oils, binders or the quality of core sands.

TWO MINUTE SULFUR DETERMINATOR Provides rapid and accurate sulfur determination of coal, coke, irons, alloy steels and other ferrous or non-ferrous materials. Time required for a complete analysis, exclusive of weighing samples, is 2 minutes. For both preliminary and final sulfur determinations.



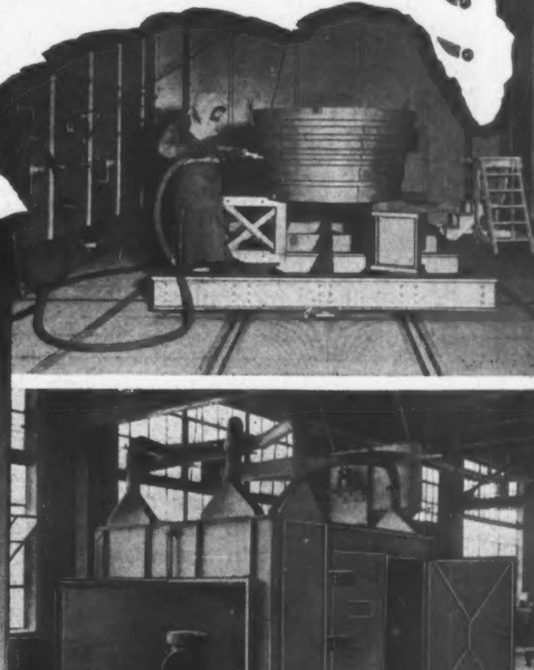
PERMEABILITY METER You can make accurate shop control permeability readings within 15 seconds with the Permeability Meter. Widely used for measuring green, dry and baked A.F.A. permeability of molding sands, cores and molds. Use the Permeability Meter to improve sand conditions in your foundry.



CONTROL SAVES TIME EQUIPMENT

Harry W. Dietert Co.

9330 ROSELAWN • • • DETROIT 4, MICH.



5 REASONS FOR CLEVELAND TRAMRAIL CORE-HANDLING EQUIPMENT

Above: After baking the racks are taken directly to molding floor. No time-consuming rehandling of cores.

Below: Coremakers' plates of cores are placed on racks conveniently located. When racks are loaded, they are propelled into ovens.

1 ELIMINATES REHANDLING — Delivers cores from coremaker to oven, thence to molding floor, via overhead tramrail route without rehandling.

2 CUTS COSTS — Saves time, speeds production, cuts costs. Coremakers spend more time making, less time handling cores.

3 REDUCES BREAKAGE — Easy operating carriers on smooth overhead track eliminate damaging vibrations and shocks. No chafing, cracking, or breaking of cores in transit.

4 NO REINFORCEMENT WIRES — Because of cushion-like handling with Cleveland Tramrail reinforcement wires can be eliminated for many cores. (Removing core wires sometimes costs more than cores themselves.)

5 WITHSTANDS OVEN TEMPERATURES — Cleveland Tramrail carriers are designed for usual oven temperatures up to 450 degrees F. No "sticky" wheel bearings.

Cleveland Tramrail core-handling equipment is inexpensive. It is easy to install in present plants. It is ideal for use through continuous baking ovens.

Now is the time to consider establishing real efficiency in your core department. Have an experienced Cleveland Tramrail sales engineer offer you recommendations — no obligation, of course.

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Gray Iron Division Preparing Data on Numerous Subjects

THE research and development that has been done on gray iron in the past few years has been phenomenal. This work has gradually, but surely, placed gray iron in the category of an engineering material which, if used correctly, will give results that can be obtained by no other metal. Gray iron has been so improved that it now takes its place among the metal aristocracy.

The American Foundrymen's Association, through the Gray Iron Division, has acted as a clearing house for much of the information on this improvement of gray iron. The activities of the various committees that comprise the Division have offered, and continue to offer, opportunities for men to band together and direct their efforts along a common channel. Cooperation has meant progress.

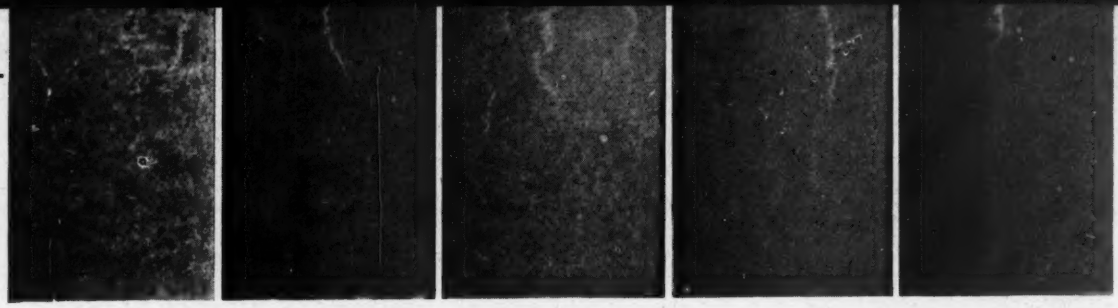
The committees of the Gray Iron Division have been extremely busy. The Cupola Research Project Committee has been working on the tremendous job of producing a cupola handbook. The Subcommittee on Engineering Properties Symposium will soon publish a symposium of gray iron properties that will be a great aid in helping the designer use gray iron to the best advantage. The Committee on Inoculation also will soon publish a symposium. The Committee on Analysis of Casting Defects has been most active in their study of defects, which is being continued, and the committee had planned a program for the shop operations course. The Committee on Chill Tests has been collecting data on chill tests and will correlate it into a recommended practice for that particular method of control. The cooperation of the Committee on High Temperature Properties of Gray Iron with A.S.T.M. Committee A-3 has resulted in a tentative specification covering the use of gray iron up to 650° F.

The committee roster of the Gray Iron Division is replete with names of excellent foundrymen, engineers and metallurgists who have actively and willingly participated in the work. The gray iron industry owes them much for their effort. Other members of the association who are interested in this work are heartily invited to participate. This invitation is particularly extended to the younger members who can bring new thoughts and new life to the committees.

Thomas E. Eagan

THOMAS E. EAGAN, *Vice-Chairman,*
A.F.A. Gray Iron Division

THOMAS E. EAGAN, Chief Metallurgist, Cooper-Bessemer Corp., Grove City, Pa., has been an active worker in gray iron activities of A.F.A. for many years. Vice-chairman of the Gray Iron Division, he also serves on the Association's War Metallurgy Committee and is Chairman, Committee on Program and Papers, Gray Iron Division, as well as an ex-officio member of all Gray Iron Division committees.



(1) (2) (3) (4) (5)

Table 1

PHYSICAL PROPERTIES OF UNBONDED BASIS SANDS

Physical Properties	(1) *Ottawa Crude Wet (Y)*	(2) *Missouri Crude Wet (O)*	(3) *Missouri Crude Dry (O)*	(4) *Missouri Crude Dry (G)*	(5) *Missouri Crude Dry (M)*
	Basis Sands				
Moisture, per cent	3.2	3.0	3.0	3.2	3.0
Green Permeability	280	190	190	110	140
Green Compression Strength, psi.	0.7	0.7	0.5	1.0	1.0
Required for 2-in. Cyl., grams	176	168	166	172	160
Required for 1⅛-in. Cyl., grams	53	48.2	51	51.5	48.7
Hot Strength at 2500° F., psi.	2.5	4	1	3.5	4
Hot Deformation at 2500° F., in./in.	0.0125	0.055	Very High	0.050	0.040
Total Expansion, 0.001 in./in.	0.015	0.01675	0.0148	0.01475	0.01475
Total Contraction, 0.001 in./in.	0.008	0.01525	0.0148 (3 min. 45 sec.)	0.01475 (7 min. 40 sec.)	0.01475 (10 min.)

MOLDING SAND PROPERTIES
at Elevated Temperatures

By L. A. Kleber and H. W. Meyer,
General Steel Castings Corp. (Commonwealth Plant), Granite City, Ill.

IN THE foundry with which the authors are associated, five different basis sands are used in mold and core mixtures for the production of carbon steel railroad specialties such as locomotive beds, tender beds and frames, water bottoms, Pullman trucks, engine trucks, cradles and other auxiliaries. Certain heavy army ordnance castings in alloy steel are currently produced; also, heavy maritime castings. Weights of individual castings run from a few hundred lb. to 120,000 lb., with a majority of the castings weighing above 15,000 lb.

The use of a particular basis sand is dictated by economy, availability, method of molding, kind and size of casting and the sectional thicknesses involved. In a specific mold or core mixture no more than two basis sands are employed.

A well-equipped sand testing laboratory, operated 24 hrs. daily, checks and records a substantial number of the mold and core facing sand mixtures, and a lesser number of the mold and core backing sand mixtures which, together, account for the daily use of 1200 to 1400 tons of new and reclaimed sand. At the present time, all mold and core facing mixtures are made with new sand only.

The routine check and recording of mixtures includes moisture content, green and baked dry permeabilities, green and dry compression strength and tensile strength. A dilatometer is used principally for investigative purposes, although expansion, contraction, deformation, shock and hot strength determinations are made and periodically checked for each standard mold, core and backing sand mixture.

Since the dilatometer is a relatively new tool in foundry use (about 2½ years in this foundry)

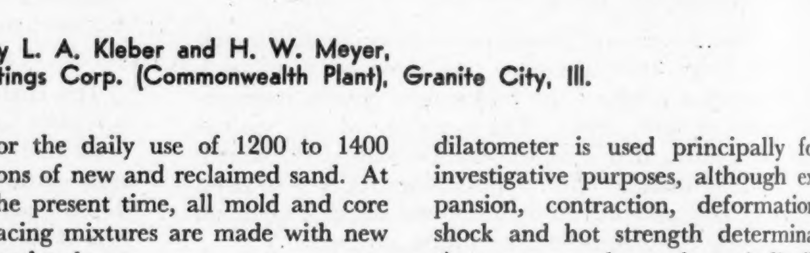


Fig. 1—Expansion-contraction curves for unbonded basis sands. These tests were made at a temperature of 2500° F.

and since it opened up a new field of observation, the authors have chosen to employ it in exploring this new field rather than to confine its use to routine checks.

The results of the initial work with the dilatometer were compared with published data and, on this basis, a number of the sand mixtures used were found to be faulty in that spalling, shelling or cracking occurred under shock testing (introducing a specimen 2-in. long by 1⅛-in. diameter at room temperature to a 2500° F. atmosphere for a period of about 3 min.).

• Physical properties of bonded and unbonded molding sands at elevated temperatures have been extensively investigated by the authors and are presented comparatively in tabular and graphic form. The paper was secured as part of the 1945 "Year-'Round Foundry Congress" and is sponsored by the Steel Division of A.F.A.

In the standard green sand mixture, one of the basis sands used is an Ottawa grade with an A.F.A. Fineness No. of 44 to 48 and a natural clay content of 2 to 3 per cent. Using this for experimentation, it was found that additions of bentonite and cereal to obtain a ratio of two parts bentonite to one part cereal resulted in a specimen having no visible defects from shock testing at 2500° F. for 3 min.

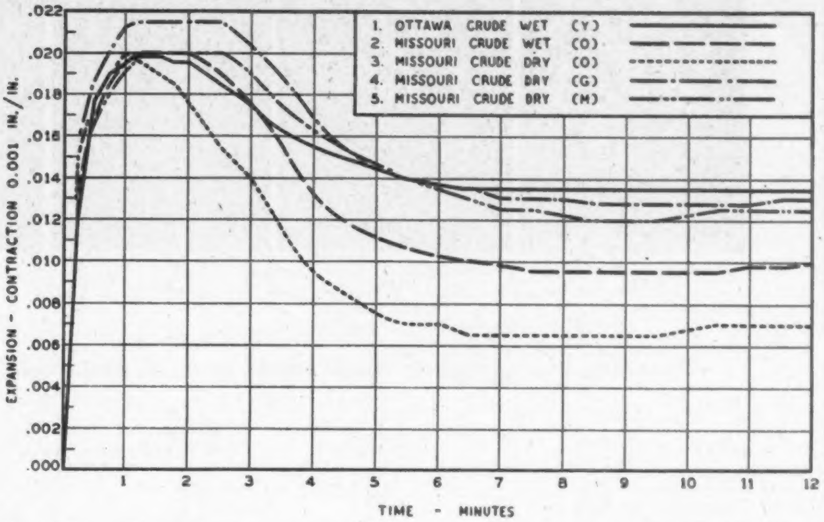


Fig. 2—Expansion-contraction curves showing effect of one per cent bentonite addition to basis sands. Test temperature—2500° F.

Changing only the basis sand to a crude Missouri grade with an A.F.A. Fineness No. of 50 to 54 and an A.F.A. clay content of 0.5 to 1.0 per cent, resulted in a specimen which, on shock testing, shelled and cracked badly. Altering the binder content to a ratio of three parts of bentonite to one of cereal eliminated the shelling on shock testing. A further adjustment in the binder ratio of four parts of bentonite to one of cereal produced a specimen which, on shock testing, did not shell, crack or show any visible defect as did other test specimens.

These results led to a broader investigation of all basis sands used. Selected samples of each were tested in a variety of ways with the results as shown in the following tables, graphs and photomicrographs (Tables 1-7 and Figs. 1-7).

Procedure

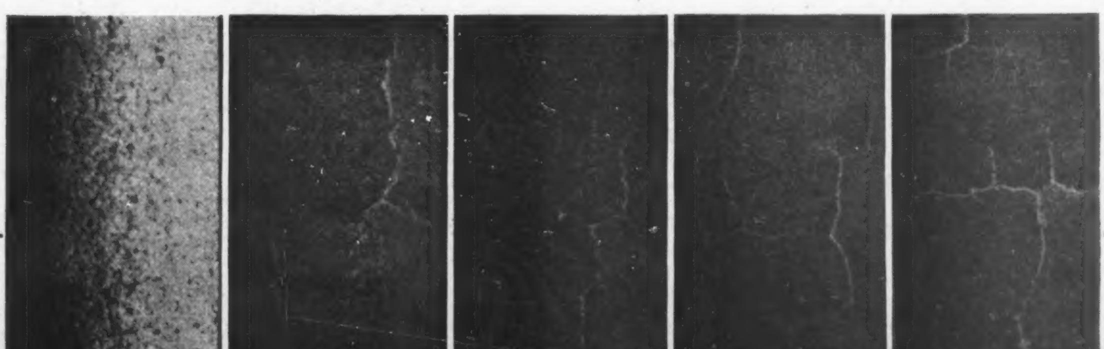
Since previous tests taken from numbers of cars arriving at the plant, particularly Missouri sands, disclosed variations in sand characteristics, the authors selected for the basis of this investigation a 1000-lb. sample from a single car, for each of the sands tested. The five samples of sand selected had been found

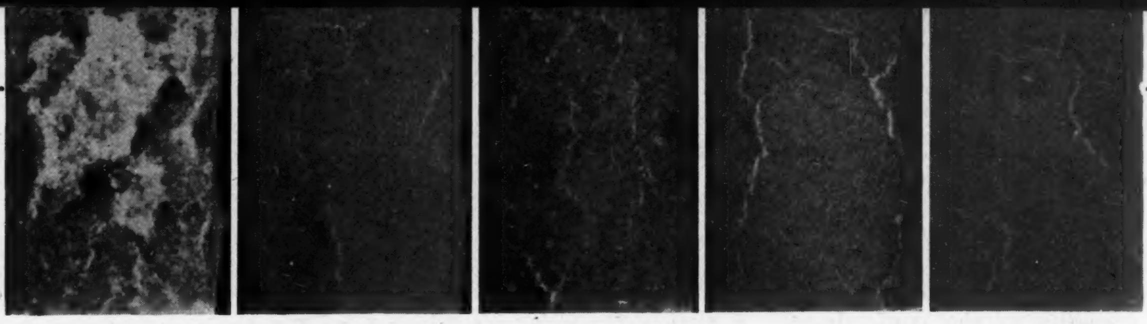
Table 2

PHYSICAL PROPERTIES OF BASIS SANDS BONDED WITH ONE PER CENT OF BENTONITE

	Basis Sands				
Properties	(1) *Ottawa Crude Wet (Y)*	(2) *Missouri Crude Wet (O)*	(3) *Missouri Crude Dry (O)*	(4) *Missouri Crude Dry (G)*	(5) *Missouri Crude Dry (M)*
Moisture, per cent	3.0	3.0	3.0	3.0	3.2
Green Permeability	210	180	190	100	120
Green Compression Strength, psi.	2.8	1.7	1.5	2.6	1.8
Increase, per cent	300.0	142.8	200.0	160.0	80.0
Required for 2-in. Cyl., grams	175	166	168	171	163
Required for 1⅛-in. Cyl., grams	53	51.6	51.6	52 5	50.6
Hot Strength at 2500° F., psi.	6	6	6	7	11-12
Hot Deformation at 2500° F., in./in.	0.020	Very High	Very High	Very High	0.035
Total Expansion, 0.001 in./in.	0.01975	0.020	0.020	0.0215	0.020
Total Contraction, 0.001 in./in.	0.00625	0.0105	0.0135	0.00875	0.008

(1) (2) (3) (4) (5)





(1) (2) (3) (4) (5)

Table 3

PHYSICAL PROPERTIES OF BASIS SANDS BONDED WITH ONE PER CENT OF CEREAL BINDER

Properties	(1) *Ottawa Crude Wet (Y)*	(2) *Missouri Crude Wet (O)*	(3) *Missouri Crude Dry (O)*	(4) *Missouri Crude Dry (G)*	(5) *Missouri Crude Dry (M)*
	Basis Sands				
Moisture, per cent	3.0	3.0	3.4	3.0	3.4
Green Permeability	190	150	150	120	110
Green Compression Strength, psi.	2.5	1.6	1.6	2.1	1.6
Increase, per cent	257.0	128.6	220.0	110.0	60.0
Required for 2-in. Cyl., grams	175	169	170	172	167
Required for 1⅛-in. Cyl., grams	53	50.9	52	51.0	49.8
Hot Strength at 2500° F., psi.	1½	3	2	3½-4	5½-6
Hot Deformation at 2500° F., in./in.	0.010	0.0425	0.030	0.055	0.055
Total Expansion, 0.001 in./in.	0.012	0.01525	0.0135	0.017	0.01625
Total Contraction, 0.001 in./in.	0.008	0.01525	0.0135	0.017	0.01075
		(8 min. 15 sec.)	(3 min. 57 sec.)	(7 min. 30 sec.)	

to give a representative average shock test result for that sand.

All green sand testing was done in conformity with the standard American Foundrymen's Association testing procedure.

Unbonded basis sands were not milled in the laboratory muller type mill. Tempering to desired moisture was done by hand mixing in a large mixing bowl. This was to insure the minimum amount of segregation and loss of clay substance in unbonded sands. Basis sands, to which binders and other mixture ingredients were added, were mixed one min. dry in a muller type laboratory mill, after which the predetermined amount of water was added and the mixture mulled 4 min.

Dilatometer test specimens were dried for one hour at 200 to 220° F. and stored in desiccators until time of testing.

Deformation Tests

Shock tests were made by exposing test specimens at a temperature of 2500° F. for 3 min.

Hot strength and deformation tests were made by determining the compression strength in psi. after 12 min. soaking at 2500° F.

Expansion and contraction values were obtained at a temperature of 2500° F., recording them at 15-sec. intervals for the first 2 min. and every 30 sec. thereafter for a total testing time of 12 min. Contraction values were not recorded after test specimens had contracted to their original length in less than the 12 min. testing time.

The data as presented are an informative story of the physical characteristics of the five unbonded basis sands and the resulting change in physical characteristics when bentonite, cereal binder and other mixture ingredients were introduced to these sands. Values given were obtained by repeated tests, and the authors now accept them as giving a definite pattern of results, indicative of what one would expect, and (when applied) applicable to other mixture compositions in which these five sands may become a part. The discussion of data will be confined mostly to clarification of those values which the authors found did not conform to previously accepted ideas.

Cooling Methods

A brief consideration of the cooling methods employed by the Missouri sand producers in producing the three dry sands is important, for it has been found that they may greatly change the physical characteristics of a sand. Missouri crude dry sands *(O)* and *(M)* are cooled using coils of cool water and forced draft. Missouri crude dry sand *(G)* is cooled under normal atmospheric conditions and time.

Crude wet sand *(O)* and crude dry sand *(O)* are mined not more than 1000 ft. apart. An investigation of the two sands has shown

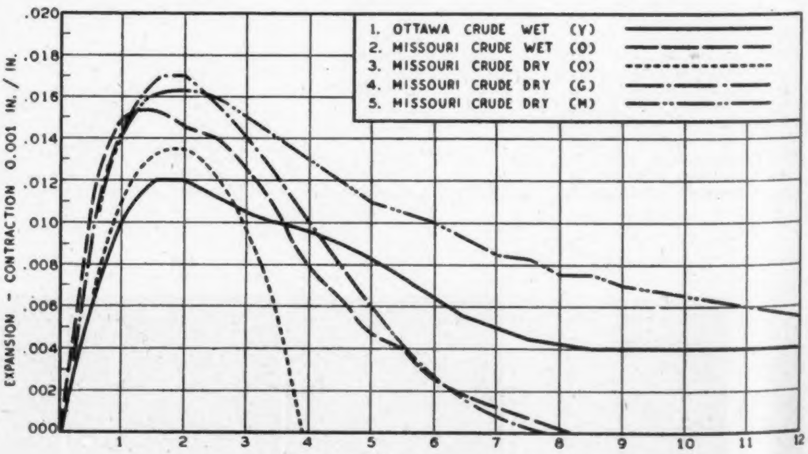


Fig. 3—Expansion-contraction curves showing effect of one per cent cereal binder on basis sands. Test Temperature—2500° F.

that these sands give reasonably identical test results throughout the various production steps, up to the operation where forced draft is employed to cool the sand.

When crude dry sand *(O)* was permitted to cool under atmospheric conditions, the sand test characteristics did not change; however, a change in test results did occur when the sand was cooled by forced draft. The use of forced draft has resulted in the removal of fine natural clay substance and other fine particles, producing a cleaner sand, which is not necessarily a desirable condition from the authors' point of view, as a study of the data will show.

A.F.A. Fineness Nos.

The A.F.A. Fineness Nos. and permeability values of Missouri crude dry sand *(O)* and *(M)* are not in the proper relationship with the three other sands comprising this report. It has been found that a greater amount of bonding material is required to give proper working strength, and that the bentonite to cereal ratio also must be increased to insure suitable specimen characteristics at elevated temperatures.

A moisture content of 3.0 to 4.0 per cent in tempered molding sand has proved to give the best casting results at this plant. For this reason it was decided to study basis sands and sand mixture characteristics within this same moisture range. However, as data were accumulated it was found that a large majority of tests were being made with sands and sand mixtures in a narrower moisture range, 3.0 to 3.6 per cent. It was then decided that for the entire study the moisture range be 3.0 to 3.6 per cent, and for indiviudal groups to have even less variation. This should practically eliminate moisture as a variable in influencing any sand mixture characteristic.

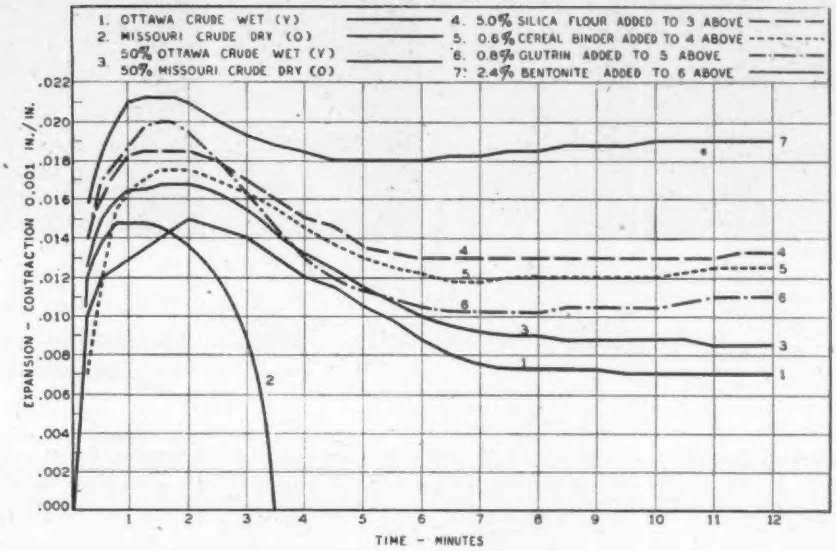


Fig. 4—Expansion-contraction curves showing influence of various additions on basis sands. Additions introduced in consecutive steps. Test temperature—2500° F.

From the screen analysis and green permeability values for unbonded basis sands, Ottawa crude wet sand *(Y)*, Missouri crude wet sand *(O)* and Missouri crude dry sand *(G)*, we find a permeability and fineness number relation which one would expect; that is, having decreasing permeability values as the fineness number of the sand increases. Missouri crude dry sands *(O)* and *(M)* are contrary in this respect. Crude dry sand *(M)* has the highest fineness number, but the permeability is always greater than the permeability of dry sand *(G)* which has a lower fineness number.

The reason for this irregularity in permeability values is due to the elimination of clay substance in cooling of sand after drying. This condition was described in the foregoing paragraphs of this paper.

The green compression strength as

Table 4

Effect of Various Additions on Basis Sand Properties

Properties	Sand Mixtures (1) Ottawa Crude Wet (Y), Unbonded	(2) Missouri Crude Dry (O), Unbonded	(3) 50% Missouri Crude Dry (O), 50% Ottawa Crude Wet (Y), Unbonded	(4) 50-50 Blend 5.0% Silica	(5) 50-50 Blend 5.0% Silica 0.6% Cereal	(6) 50-50 Blend 5.0% Silica 0.6% Cereal 0.8% Glutrin	(7) 50-50 Blend 5.0% Silica 0.6% Cereal 0.8% Glutrin 2.4% Bentonite
Moisture, per cent	3.2	3.0	3.2	3.4	3.4	3.2	3.4
Green Permeability	280	190	250	160	140	130	130
Green Compression Strength, psi.	0.7	0.5	0.5	1.1	1.6	1.5	5.5
Required for 2-in. Cyl., grams	176	166	173	175	176	175	174
Required for 1⅛-in. Cyl., grams	53	51	52.2	53.5	53.2	52.7	52.3
Hot Strength at 2500° F., psi.	2-3	1	3-4	30	22.5	22.5	16
Hot Defor. at 2500° F., in./in.	0.0125	Very High	0.015	0.025-0.030	0.030	0.030	0.020
Max. Expansion, 0.000 in./in.	0.015	0.01475	0.01675	0.0185	0.0175	0.020	0.02125
Max. Contraction, 0.000 in./in.	0.008	0.01475 (3 min. 45 sec.)	0.00825	0.0055	0.00575	0.00975	0.00325

(7)

(1)

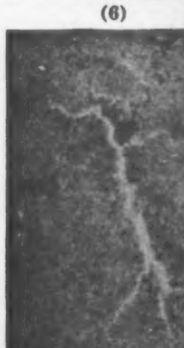
(2)

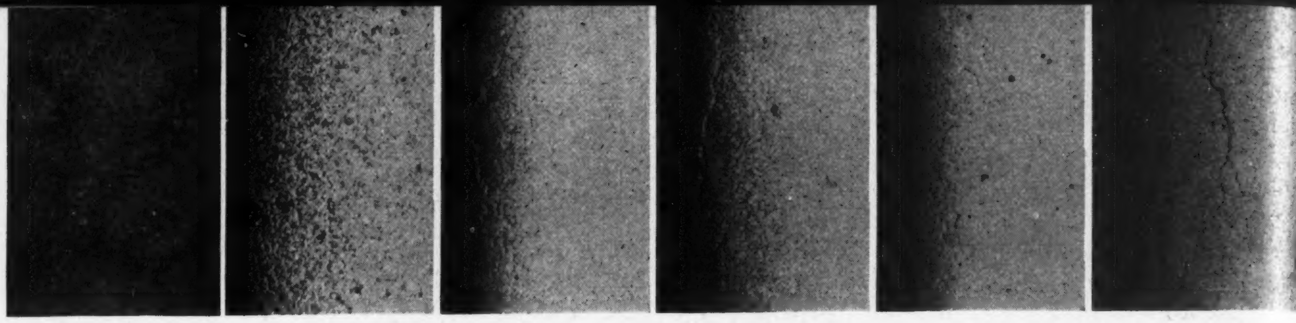
(3)

(4)

(5)

(6)





(1) (2) (3) (4) (5) (6)

Table 5

PHYSICAL PROPERTIES OF IDENTICAL MIXTURE INGREDIENTS WITH DIFFERENT BASIS SANDS

	Sand Mixtures					
	(1)	(2)	(3)	(4)	(5)	(6)
Properties	*50% Ottawa Crude Wet (Y) 50% Missouri Crude Dry (O) 5.0% Silica Flour 0.6% Cereal Binder 0.8% Glutrin 2.4% Bentonite*	*Ottawa Crude Wet (Y) 5.0% Silica Flour 0.6% Cereal Binder 0.8% Glutrin 2.4% Bentonite*	*Missouri Crude Wet (O) 5.0% Silica Flour 0.6% Cereal Binder 0.8% Glutrin 2.4% Bentonite*	*Missouri Crude Dry (O) 5.0% Silica Flour 0.6% Cereal Binder 0.8% Glutrin 2.4% Bentonite*	*Missouri Crude Dry (G) 5.0% Silica Flour 0.6% Cereal Binder 0.8% Glutrin 2.4% Bentonite*	*Missouri Crude Dry (M) 5.0% Silica Flour 0.6% Cereal Binder 0.8% Glutrin 2.4% Bentonite*
Moisture, per cent	3.4	3.4	3.6	3.6	3.6	3.6
Green Permeability	130	180	120	130	100	90
Green Compression Strength, psi.	5.5	6.3	5.0	4.0	5.3	5.1
Required for 2-in. Cyl., grams	174	175	170	171	174	165
Required for 1⅛-in. Cyl., grams	52.3	52.5	51.5	51.6	52.7	49.5
Hot Strength at 2500° F., psi.	16	8-9	15	13-14	10-11	15
Hot Deformation at 2500° F., in./in.	0.020	0.020	0.030	0.020	0.030	0.0275
Total Expansion, 0.001 in./in.	0.02125	0.02175	0.02225	0.0215	0.0215	0.021
Total Contraction, 0.001 in./in.	0.00325	0.0055	0.00875	0.0065	0.007	0.0055

found in unbonded basis sands was obtained from the natural clay bond present in the sand and the shape of sand grains. Natural clay bond in Ottawa crude wet sand *(Y)* is the contributing factor in producing green compression strength.

The Missouri sands are low in natural clay bond, and the green compression strength must be obtained from the predominating subangular shaped grains, which on being rammed become interlocking.

On examination of the photomicrographs, one can readily see the rounded surfaces and clay coating of Ottawa sand grains, while the Missouri sand grains are predominantly clear crystals with little stain. Sharp edges on the grain surfaces are also very noticeable (Table 7).

Green Compression Strength

Referring to Table 6, mention is made of the fact that washed and unbonded test specimens collapsed before testing. To further substantiate the previous statements regarding natural clay bond and shape of grain as contributing to green compression strength, the following observations made while collecting data for Table 6 should be related.

Test specimens of washed and unbonded crude Ottawa sand *(Y)* with 3 per cent moisture content would fall apart when stripped from the cylinder in which the specimen was rammed, the sand grains ranging from round to subangular. Rammed specimens of washed and unbonded Missouri sand when stripped from the cylinder would stand until drying started. This was only possible due to interlocking subangular shaped grains. The green compression strength could not be obtained due to the fact that the specimens fell apart when taken from the cylinder.

The green compression strength resulting from the addition of one per cent of bentonite or cereal binder is shown in Tables 2 and 3. This increase in green compression strength may be shown also as the percentage of strength increase.

Grams of Sand Required for 2x2-In. and 1⅛x2-In. Test Specimens

It is interesting to note that the amount of sand required to produce proper size test specimens was less when the basis sand was a Missouri sand. Also, there was considerable variation in the density relation between 2 in. and 1⅛ in. diameter test specimens. Through the entire investigation, which consisted of numerous confirming tests, it was found that the number of grams required to produce proper specimen size was uniformly consistent with Ottawa sand as the basis sand. This was not true with Missouri sands.

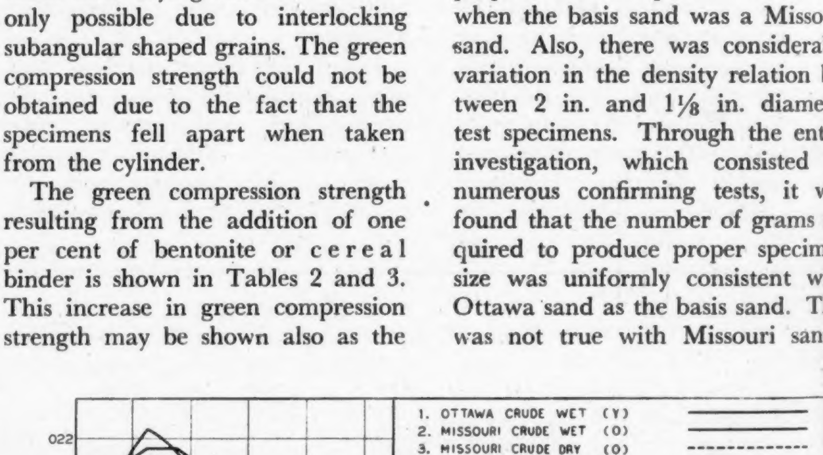


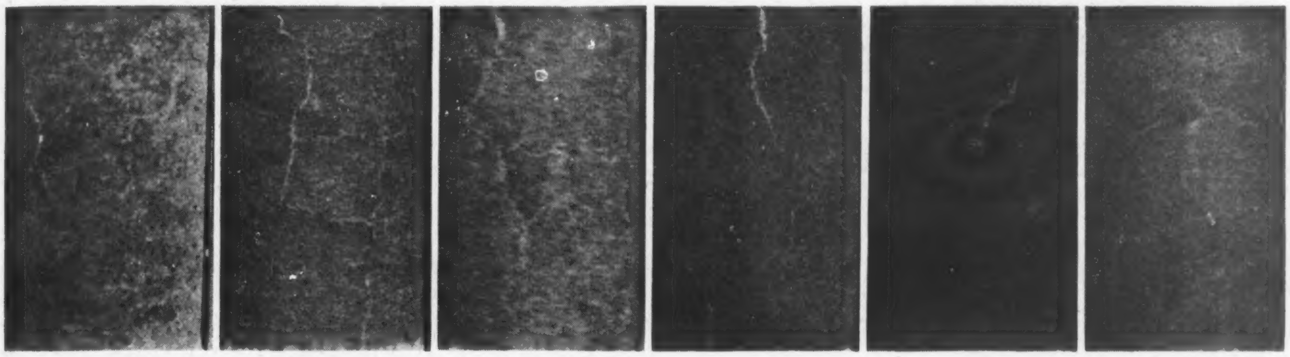
Fig. 5—Expansion-contraction curves showing effect of identical mixture additions with different basis sands. Additions are: Silica flour—5.0 per cent, cereal binder—0.6 per cent, glutrin—0.8 per cent, bentonite—2.4 per cent. Test temperature—2500° F.

Table 6

PHYSICAL PROPERTIES OF CRUDE BASIS SANDS AND OF WASHED BASIS SANDS REBONDED WITH 0.5% AND 1.0% BENTONITE

	Sand Mixtures					
Properties	(1) *Ottawa Crude Wet Sand (Y)*	(2) *Ottawa Crude Washed Sand (Y), Rebonded 0.5% Bentonite*	(3) *Ottawa Crude Washed Sand (Y), Rebonded 1.0% Bentonite*	(4) *Missouri Crude Wet Sand (O)*	(5) *Missouri Crude Washed Sand (O), Rebonded 0.5% Bentonite*	(6) *Missouri Crude Washed Sand (O), Rebonded 1.0% Bentonite*
Moisture, per cent	3.2	3.2	3.0	3.0	3.2	3.0
Green Permeability	280	260	250	190	190	180
Green Compression Strength, psi.	0.7	0.8	1.3	0.7	0.8	1.6
Required for 2-in. Cyl., grams	176	172	170	168	167	164
Required for 1⅛-in. Cyl., grams	53	51.1	51.0	48.2	50	49.5
Hot Strength at 2500° F., psi.	2-3	2	2	4	2-3	2-3
Hot Deformation at 2500° F., in./in.	0.0125	0.0125	0.0135	0.055	0.0075	0.0175
Maximum Expansion, 0.001 in./in.	0.015	0.0175	0.018	0.01675	0.01825	0.01975
Maximum Contraction, 0.001 in./in.	0.0085	0.00425	0.005	0.01525	0.0055	0.00625

NOTE: Washed and unbonded test specimens collapse before tested.



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(1)

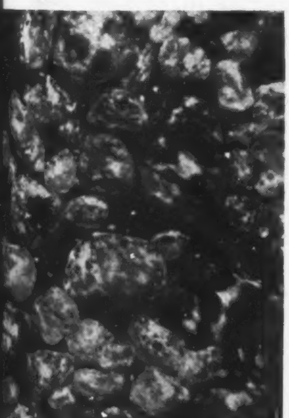
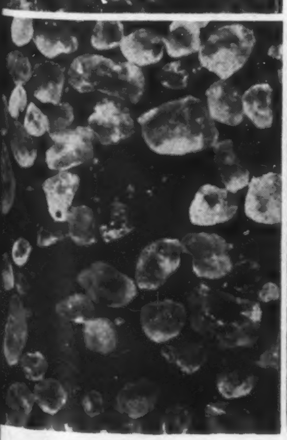


Table 7

SCREEN ANALYSIS OF BASIS SANDS

	Retained on Screen, per cent				
Screen No.	(1) *Ottawa Crude Wet Sand (Y)*	(2) *Missouri Crude Wet Sand (O)*	(3) *Missouri Crude Dry Sand (O)*	(4) *Missouri Crude Dry Sand (G)*	(5) *Missouri Crude Dry Sand (M)*
20	0	0	0	0.4	0
30	7.0	1.0	0.2	1.0	0.4
40	37.3	12.3	5.2	5.2	3.0
50	29.6	46.3	28.8	14.6	10.0
70	14.2	26.6	33.6	25.8	26.8
100	7.3	9.3	20.6	35.2	37.4
140	2.1	3.0	8.0	14.8	16.4
200	1.2	0.5	2.8	2.6	4.2
270	0.2	0.5	0.6	0.4	1.2
Pan	1.1	0.5	0.6	0.4	0.8
A.F.A. Fineness No.	44.1	48.3	58.4	65.2	71



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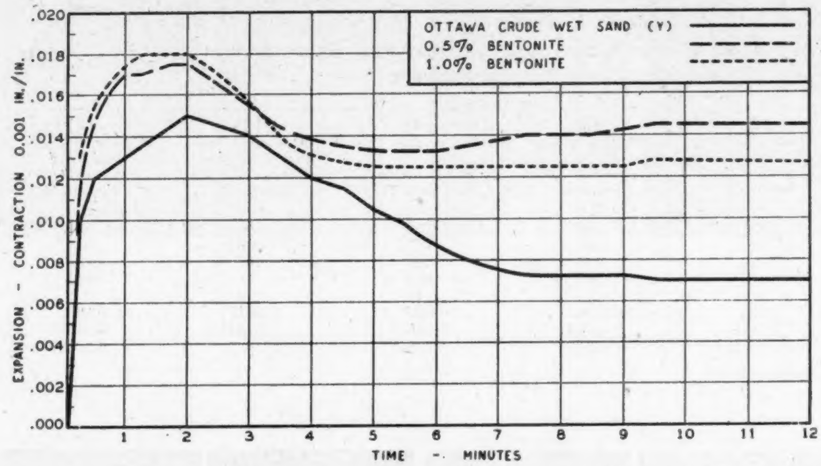


Fig. 6—Expansion-contraction curves of Ottawa crude wet sand (Y) and washed Ottawa crude sand (Y) rebonded with 0.5 per cent and 1.0 per cent of bentonite. Unbonded washed sand test specimens collapse on drying. Test temperature—2500° F.

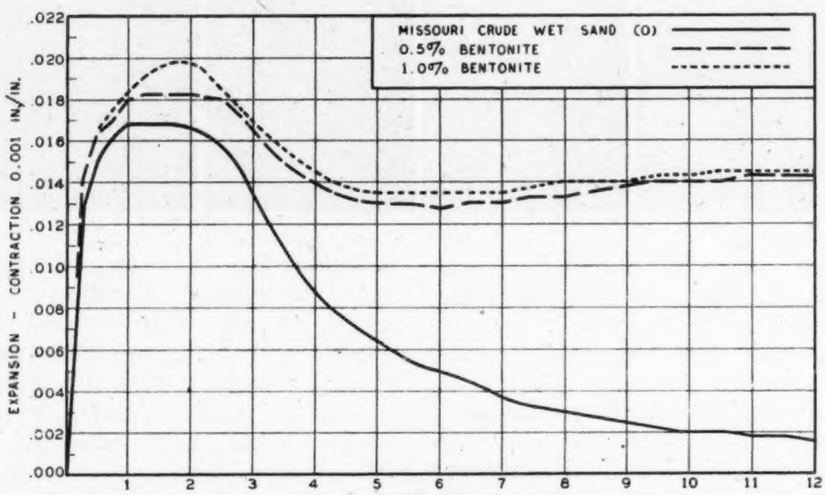


Fig. 7—Expansion-contraction curves of Missouri crude wet sand (O) and washed Missouri crude wet sand (O) rebonded with 0.5 per cent and 1.0 per cent of bentonite. Unbonded washed sand test specimens collapse on drying. Test temperature—2500° F.

The shape of the sand grains and their distribution is a contributing cause for this variation. The photomicrographs of the five basis sands (Table 7) show that the Missouri sands are subangular to angular, with many angular or elongated grains with sharp edges predominating. This angularity of grain shapes greatly retards the flowability or ramability of the sand.

Shape of Grains

The Ottawa sand grains, as the picture shows, are round to subangular, with no sharp edges on the grains, a factor necessary for high flowability. The absence of fine material in a basis sand may also affect the number of grams of sand required for proper size test specimens.

Comparison of the total influence that bentonite and cereal binder have on the hot strength of unbonded basis sands cannot be determined from the data. Unbonded basis sands were tempered by hand. To measure the total influence that these binders have on the basis sands, it would have been necessary to mull each of the unbonded sands in the laboratory mill for the same period of time that the sand mixtures were mixed and tempered. Mulling brings about a certain amount of sand grain breakdown, introducing a slight silica flour effect, which will increase the hot strength. With this exception the data do show that bentonite will increase hot strength, while cereal binder will reduce it.

The accuracy of the readings in this test is doubtful, in the opinion of the writers. That is why, on several occasions, when the values were more than 0.055 in./in., a written description as "very high" was used instead of numerical values.

Total Expansion and Total Contraction at 2500° F.

The total influence that additions of bentonite and cereal have on the expansion and contraction characteristics of basis sands cannot be determined from the data. Pioneers in sand testing at elevated temperatures early discovered that cereal binders decreased the rate and amount of expansion and increased the rate of collapse.

Comparing the dilation curves of Figs. 1 and 3, we find that the rate of expansion was retarded, as one would expect. However, not in every case was the total expansion reduced; neither was the total contraction or rate of collapsibility increased. Ottawa crude wet sand *(Y)* and Missouri crude wet sand *(O)* follow the pattern that one would expect. The Missouri crude dry sands *(G)*, *(M)* and *(O)* have not followed this pattern completely.

As previously stated, when discussing hot strength characteristics, the same influence that was brought about by mulling in mixing and tempering of basis sands to which binders or mixture ingredients were added, also affects the expansion and contraction characteristics.

As an added thought, segregation of sand grains, permitting an accumulation of more than average amount of "fines" for that particular basis sand, also may have the same influence on sand characteristics. These influences may be small and not noticeable in green or dry sand testing, but their influence is very noticeable in testing at elevated temperatures.

Conclusions

The data presented indicate that similar sand mixture bonding ingredients, of like proportions and used with different basis sands, are apt to produce widely different results at elevated temperatures.

The sand mixtures productive of the best elevated temperature shock test results and the cleanest casting had high expansion-low contraction characteristics.

The use of bentonite reduced contraction in all of the sand mixtures tested; it likewise contributed most to the reduction or elimination of

shelling, spalling and cracking in the sand mixtures tested.

Some basis sands require larger amounts of bentonite than others to produce equal results.

Missouri sands with bentonite-to-cereal ratios capable of producing best elevated temperature test results had relatively low flowability.

The influence of any mixture ingredient may vary with the kinds of basis sands used.

Laboratory observations in elevated temperature testing were found to reasonably parallel casting results. The use of sand mixtures which showed poorly under laboratory test always resulted in the castings having one or a number of the defects attributable to molding sand, and usually to the degree observed in laboratory tests of the sand mixtures at elevated temperatures.

Room temperature tests are of chief importance in the control of molding sand requirements up to the time of pouring. Tests at elevated temperatures are indicators of occurrences when metal enters and fills the mold.

The best casting results obtain from a sand mixture with proportions of bonding materials adjusted to suit the characteristics of the basis sand used. Under varying conditions and requirements of casting production, the selection of different basis sands may be advisable.

ADMINISTRATION CONGRESS

To Be Held in Chicago July 17-19

IN LIEU of the 1945 Foundry Congress of A.F.A., canceled in compliance with the Government's request to minimize transportation use, an "Administration Congress" will be held at the Palmer House, Chicago, July 17-19. Concentrated in three days will be the 2nd annual Chapter Chairman Conference, the Annual Meetings of the 1944-45 and 1945-46 Boards of Directors, and the Annual Business Meeting of the Association.

Attendance at the 3-day Congress, which brings together the administrative officials of A.F.A. and its Chapters, is necessarily limited. In accord with ODT requirements, invitations have been extended only to official Chapter delegates, in addition to National Officers and Directors.

The Chapter Chairman Conference, scheduled for July 17-18, has become an important factor in coordinating the national and local activities of the Association. The first meeting last August proved highly successful, and 100 per cent Chapter representation is expected in July.

Following a joint luncheon with the Chapter chairmen, the 1944-45 National Board will convene the afternoon of July 18 for its annual meeting. The evening will be given over to a dinner and the Annual Business Meeting of the Association.

A.F.A. members residing in the Chicago Chapter area have been invited to attend, reservations being handled by the National Office of A.F.A., 222 West Adams St., Chicago 6.

National President R. J. Teetor, Cadillac Malleable Iron Co., Cadillac, Mich., will preside at the Business Meeting. A feature will be the presentation of A.F.A. Gold Medals and Honorary Life memberships to five outstanding men who have contributed greatly to the advancement of the foundry industry. Announcement will be made of winners in the 1945 National Apprentice Contests. Dr. H. A. Schwartz, National Malleable & Steel Castings Co., Cleveland, will discuss the subject of his 1945 Foundation Lecture, "Solidification of Metals."

The newly elected Officers and Directors of the Association will be announced and presented at the meeting, following elections held in accordance with the By-Laws. As a special feature, Max Kuniansky of Lynchburg Foundry Co., Lynchburg, Va., and a National Director, will present a short practical-technical talk on the possibilities of "Castings in Postwar Industry."

Concluding the "Administration Congress," the 1945-46 Board of Directors will hold its annual meeting on July 19.

1945 Foundation Lecture Distributed to Members

THE complete text of the 1945 Foundation Lecture on "Solidification of Metals," by H. A. Schwartz, National Malleable & Steel Castings Co., Cleveland, has now been distributed to all A.F.A. members gratis. In his lecture, dealing with a subject of great interest to all branches of metal casting, Dr. Schwartz has further added to his many outstanding contributions to the literature of the industry.

Dr. H. A. Schwartz

In pamphlet form, the lecture covers 78 pages of text and bibliographic references, with 52 illustrations and a number of interesting tabulations based on his broad study of solidification phenomena. The paper is of special interest at this time in view of the work now being sponsored by the Technical Development Program of A.F.A. on heat transfer effects, at Columbia University and the Naval Research Laboratory.

Established in 1942, the A.F.A. Foundation Lectures have produced several authoritative discussions on foundry problems. The first lecture was presented by John W. Bolton, The Lunkenheimer Co., Cincinnati, at the 1943 Foundry Congress. In 1944 the lecture was given by H. W. Gillett, Battelle Memorial Institute, Columbus, Ohio, at the Buffalo convention.

A digest of the 1945 lecture was published in the June 1945 issue of AMERICAN FOUNDRYMAN. Dr. Schwartz has accepted an invitation to discuss foundry problems further at the annual business meeting of A.F.A., to be held in Chicago on July 18.

Sound Wage Incentives

By Harry Reitinger,
The Emerson Engineers, New York

Wage incentive plans should be explained clearly and fully to shop men.

WHEN a wage incentive plan seems to be the answer to a problem of wage inequalities—and in almost every plant it *is* the answer—do not think that you can simply decide to have an incentive plan, and expect both management and workers to throw in together. All evidence must be available. It must be in black and white, clear enough for both to understand, and foolproof enough so that the money involved can always be properly accounted for.

We all know that, basically speaking, an incentive plan gives extra pay for extra production—and if the incentive plan is functioning correctly it should and will encourage that extra production.

The question then arises: What incentive plan? There are several, and as many different ways of installing them as there are engineers to do it. All systems are based on establishing a level, or normal amount of work done, and paying extra for work accomplished above and beyond this norm.

Gain-sharing System

First, there is the gain-sharing type of system. Under such a plan, a worker receives his compensation for extra production above average output for time involved, but at a rate of pay which allows management to share in the gain, under the principle that management had a great deal to do with making it possible for the worker to *earn* that extra, so there should be a split on the extra.

For instance, if a man does 10 hours work in 8 hours, he is paid his entire rate for the eight hours, plus about 75 per cent of his regular hourly rate for the extra two hours. Management feels that it deserves the remaining 25 per cent for making it possible for the worker to speed up. For this reason, most unions do not like gain-sharing systems, and they tend to breed much dissatisfaction.

The worker feels, and justifiably so, I believe, that if he has produced more pieces in a shorter length of time, he is entitled to full pay for so doing, particularly since, as is obvious, the unit cost of each piece produced is lowered by a faster rate of production.

Another system is called the "step bonus," or the payment of a lump sum to the worker after a certain production level is reached. Yes, the bonus is an incentive,—to reach the level at which the bonus is paid—but not an incentive to increase production beyond that level

Why should the worker exert himself? He gets no more money *after* the bonus level. This step bonus plan can be discouraging to those workers who do not have the ability to reach the bonus level, and who finally become disheartened and quit trying.

Still another is a "group incentive" plan, used mostly when it is impossible, because of the nature of

• Sound incentive systems mean increased production . . . more "take home" pay for workers, decreased cost for management. Confidence must be established by accurate basing and a full, clear explanation of the advantages offered by the particular wage incentive plan selected.

This paper was secured as part of the 1945 "Year-'Round Foundry Congress" and is sponsored by the Committee on Time Study and Job Evaluation.

the work involved, to measure the output of a single employee. The production of a group of employees is measured, a norm is set up and over-production is paid for on the output of the entire group. It is then divided equally among the individuals in proportion to their weekly earnings.

This system depends almost entirely upon the type of people making up that group. If the workers get along together, if there is no animosity within the group to start with, a group incentive plan can work out successfully. A group incentive plan encourages the workers to be more closely united. It teaches them to work together, to give help and advice where needed and, in some measure, reduces favoritism and the handing out of "gravy" jobs.

Here individual jealousies, a factor to be contended with and minimized, are considerably reduced. Of course, a group incentive should be applied only where it is impossible to measure the work of individuals.

Some systems go a step further than group incentives and become plant-wide incentives. These are employed only when a plant wishes to install an incentive system immediately, and as a temporary measure until a smaller group or individual incentive system can be set in operation.

Standard Time Plan

I like the incentive plan which pays the individual a bonus, based on an unchanging unit, namely, "standard time." The "standard time" is the number of minutes or hours in which a given task should be completed.

Because this plan is so simple and yet so efficient, I believe that it is the incentive bonus plan which *does* have all the answers—the plan which is fair to management, fair to workers; it is the most direct way of measuring the output of an individual, and recompensing him according to his ability.

Management is offering workers a five-dollar bill for 50 cents, so to speak, but management has all the evidence in using a system of incentive based on standard time—evidence that it is not buttering up the workers for a good roasting. And if unions offer that plan to management, they too have the same valid arguments. Unions offer more production, and consequently more profit; they receive in exchange a higher rate of pay commensurate with individual ability.

It should be stressed that the justification for any incentive plan, the value of it, the fairness of it under any given set of circumstances, depends upon the way it is set up. It must be airtight and foolproof—and I believe that a bonus incentive paid on the basis of an accurate measure of standard time is just that.

Operation Timing

Timing of any operation has earned for itself a bad name. Many unions have complained, and with more than a small measure of justification, that some methods of timing or "speed-rating" are simply ways of eventually lopping off the pay check.

This is because the original standard time set for an operation was not set accurately and carefully. This is what happens. Those few of management who have been taking every possible means to cut salaries insist on re-timing an operation frequently.

In so doing they are careful to pick the fastest man and set the stop watch by his speed. As a result, the supposed "average" or normal production which the other workers are supposed to exceed in order to receive a bonus is really top speed rate, higher than only the best man can ever hope to reach. Therefore, no bonus is paid.

Unfortunately, some have gone even further. As soon as operators have stepped up their output to earn their bonus, even though the timing has been set at somewhere near the normal level, management has stepped in and, on some excuse or other, re-timed the operation, and reset the norm on the basis of stepped-up production.

This does not imply that management as a whole should be blamed for what a few of the more unscrupulous have done to abuse a good plan. However, if an efficient job is to be done in setting a standard time, it must be done on the basis of the conditions and methods of performing the operation.

This does not mean the operation as it is running now but the operation after it has been studied and perfected—after it becomes certain that with present knowledge that operation is being performed at a normal rate of efficiency.

Production Factors

Every one of us knows that work of any kind is accomplished with the least fatigue under these three conditions:

1. When an operator attains form in operation, when he can complete an operation with ease and facility, he can accomplish remarkable results with minimum fatigue.
2. If an operator is interested, he can endure temporary strain without harm.
3. It is always easier to accomplish a definite task than to accomplish the same work without predetermination.

For a given time, a definite result should be set. Furthermore, that time should be so set that an average good operator can beat it easily. Thus he can develop form and interest in the operation in a double manner—first, by beating the time, and second, by receiving a reward.

For the purpose of figuring the bonus, the efficiency of the operator is measured by dividing the standard time by the actual time; that is, taking the time set as efficient for the job and dividing it by the time in which the individual operator does it. For purposes of converting the figure into a percentage, it is multiplied by 100. The answer is the percentage of efficiency on a time basis.

Basis of Bonus Payment

Next comes the actual bonus itself. We have set the standard time of the operation and have found the efficiency percentage of the operator. Just how much money does the worker get after stepping up his work?

First, it must be remembered that since the basic unit is the hour, and all measurements are made on a time basis, changes in wage or wage rates do not affect the efficiency calculations—nor does the compari-

son of one period with any other period affect it.

Furthermore, the comparison between a machine molder and a pattern maker is fair because they are measured on the same universal basis, standard time.

It is obvious that when the actual time and the standard time are the same, performance is 100 per cent. Our organization has used and endorsed the system that bonus payments start at 80 per cent efficiency; first, because we believe the 80 per cent line offers an inducement to the worker to reach standard time and exceed it; and second, because such a margin takes care of fatigue, error and other allowances. Stated bluntly, we are none of us perfect, and it is only fair that the figures show it.

For each one per cent increase in efficiency the worker receives one per cent of his pay period straight time pay as a bonus. Thus at 100 per cent average efficiency, he receives 20 per cent of his pay period straight time as a bonus, and at 120 per cent efficiency he receives 40 per cent of that pay as a bonus.

Job Standards

It can be seen by this that no matter what the fluctuation of the base wage scale, this bonus rides right along with it. And this works out so that each worker is paid for all the time he saves.

Furthermore, since the standards set are basically correct, since they have been handled with as much care as is humanly possible, there are no easy jobs and there are no hard jobs. Each job's standard is fixed according to the job itself, each standard is individual and is not influenced by another job.

This eliminates any human tendency of an operator to push hard on the easy job so as to get more money, and to lose interest in the hard job. Since his bonus is based on his pay-period efficiency, he will plug hard to maintain a high pay-period efficiency.

The same standards apply to a beginner as to a skilled worker. As a beginner approaches and passes 80 per cent efficiency, he receives his bonus based upon his lower hourly rate, just as a skilled worker would receive it on his higher rate.

Such a bonus focuses the attention of both worker and the management on time, output, and quantity instead of rates. The hourly and daily wage rates are established by bargaining and job evaluation, and when set usually remain stationary for some time.

Re-timing Unnecessary

If the original setting of the standard time has been handled with care, there is no need for, no reason for the frequent re-timing that workers so much resent. There is no opportunity to readjust the efficiency level and make it higher if the workers themselves have, because of the incentive, raised their own efficiency. Efficiency is set on the job itself, and as far as possible on human capabilities, not on historical records of this job, nor on pace-setting performances.

These standard times should be studied and set by an unbiased agency—an engineer or group of engineers employed by the firm only for this job. If this is done, neither management nor labor can complain that one or the other set it up to suit one faction and thwart the other.

How is the bonus paid? It is figured on the basis of the worker's average efficiency over a pay period, his average straight time earnings during that period. Obviously, the average is taken to save an immense amount of clerical work, and there is, therefore, only one calculation to be made for each worker at the end of each pay period.

For psychological reasons, the bonus should be figured and paid separately from the guaranteed pay. Let the worker see in black and white right on his pay record just how much he has earned over and above his salary.

It is inevitable that he will talk it over with some of his friends in the plant—and inevitable that he will learn how his ability compares with the others. If he is satisfied with the original timing of his job, satisfied with his job, then he knows it is absolutely up to him as to how much "take home" pay he gets.

Worker Efficiency

Of course, the job order shows the standard time for the job the worker is doing at any given moment. He can figure his own efficiency at any time, check and compare it with the record in his pay envelope.

Because a worker's efficiency goes up, this does not and should not lower his basic hourly rate of pay. He is guaranteed this hourly rate as long as he is in good standing and has been asked to report for work. The only relation the bonus has to the hourly rate is in that the percentage of efficiency is paid for in direct relation to this established rate for his job.

We have been discussing the advantage that an incentive plan, properly handled, has for workers. But, what about management? No doubt about it, management is just as satisfied as the worker who sees his pay envelope swell by dint of his own efforts.

A good bonus system reduces unit labor cost and reduces the *total* unit cost by distributing overhead over a greater output. Furthermore, it provides a means of direct comparison of the efficiency of the workers, departments as a whole, divisions, and, yes, even a direct comparison of entire plants.

Naturally, such a comparison is invaluable to management in getting an accurate picture of just what is happening, even to the most remote detail of any job.

Basis of Wage Increase

Another point in direct relation to the lowered unit cost is the fact that lower unit cost is the only basis on which the War Labor Board grants an increase in wages. Therefore, with an incentive plan in good operating order in the plant, wages can be increased, but in terms that are commensurate with the worker's ability. Because the worker himself is responsible for lowering the unit costs, i.e., by increasing his own production, therefore, the worker himself is responsible for his own pay increases.

I cannot say too strongly that close cooperation between all concerned is absolutely necessary to make a success of any wage incentive plan. If both management and workers know what the other fellow is up to—if all parts of the affair are down in black and white in simple language for everyone to understand, we will find that a sound wage incentive plan will be acceptable.

From the first moment a management decides to install such a system, not only must the unions involved be consulted, but the individual worker must be informed. A

printed outline, clearly organized, and understandably written, is always helpful.

Before a man's job is investigated and analyzed in order to determine the standard time for the operation, the worker himself should be consulted for suggestions. Perhaps there is a difficulty about the operation which he would like straightened out. Perhaps he has an idea for improvement of the operation, but has had neither the time nor quite enough knowledge to go about making that improvement.

A wise, thorough engineer can help him. It must be explained to the worker that the reason his job is being timed is to ascertain a time within which the job can be completed with maximum efficiency—that it is not being done in order to cut his pay, but in order to help him earn more money.

If this is done, nine out of ten workers will throw in with the management and end up by being as eager and interested in the whole project as the originators.

Operating Delays

Once an incentive system is installed, delays to operators and machines must be avoided. If there is a bonus awaiting "Joe" while he is working, he is not going to be very happy about sitting round waiting for work.

It is always wise to check the office or desk from which the planning, scheduling and dispatching of work comes. See that they keep ahead of the worker, keep him busy with just as much work as the man wants and can take.

Needless to say, the machine setup must be done correctly, and so as not to interfere with the worker. The work in process should be well-timed so that if one man is dependent on the output of another to get his work, he need not be delayed. Arrange it so that the man who would ordinarily be waiting for work because he is faster, is able to get his material from a second person when he needs it.

The question of preventive machine maintenance is always present. A breakdown in a machine is quite a sour proposition to the worker if it means a breakdown in his bonus as well.

When I outlined the setting of the standard time for an operation, I mentioned that there should be little need for re-timing a process if the original work has been done with care and skill. I did not amplify it at that point, because I wanted to bring it up again here, under this general series of cautions.

Occasions for Re-timing

As previously stated, frequent re-timings are unnecessary. There are occasions when, say, improvements in the machine or methods or both have been installed and the operation can be accomplished in a much faster time than before—and I repeat, because and only because improvements have been made, not because the man has attained a higher degree of efficiency, is re-timing in order.

If the improvements have been installed through the initiative of the management, then, having gone through the proper channels, the job should be re-timed. However, this should not result in a loss of pay for the worker; if it does, it is evident that either the new time or the old is inaccurate—and it will mean a most disgruntled employee.

If the improvement has been installed through the interest of the employee—if he has suggested or designed the improvement, then he should have the credit for it, if it is even in the least traceable to him.

Lump Sum Payments

Perhaps the management may find it the wisest plan to pay the employee a lump sum for the improvement, equal to what his earnings would be if he were paid on the basis of his new output and his old standard time over a period of one year—in other words, a year including what he would normally receive on an average, plus the bonus, payable at the same rate, on the difference between the old and the potential new output.

Then the operation can be re-timed without any hard feelings, and the actual normal rate of the man and machine will be in keeping with normal rates on other machines that have not had a major improvement.

Some companies may prefer to let the man increase his own bonus by allowing him to work on his old standard time and step his production above standard as much as the improvement will let him, taking his proportionately increased bonus. I rather like the former method; it prevents jealousies being continued over a long period of time.

Still another problem almost always offers itself whenever and wherever an incentive system is installed. And it is—what shall we do with the day workers—workers whose jobs cannot be figured on the basis of operations—workers who are just as vital to the production of the plant, and yet whose output cannot be easily measured?

Day Workers

Consider the case of a cupola tender, for instance. How can he be placed on an incentive basis; one which is commensurate with his ability? How can he be paid a bonus for extra production?

That question is not as much of a poser as it may seem, even though it is getting rather close to another subject, that of job evaluation. It can be answered with little detail that in such cases, if a man's job is evaluated carefully, not of course on a standard time, but estimated, evaluated, he will be getting an hourly rate commensurate with his ability and skill.

However, that does not completely settle the day worker's lot. If the rest of the plant are on incentive pay and have stepped up production, the day worker also must work harder, step up his own production to keep pace with the incentive workers.

In a great many cases, and with much to be said for their point, unions have fought for and won extra-production pay for day workers who are employed along with workers on incentive pay. In other words, suppose production had, as an over-all picture, increased 35 per cent among incentive workers. The day workers, who must also have stepped up production, should also receive extra-production pay amounting to the same percentage.

Summary

Establishing a good, sound incentive system in a plant means that production is increased, "take home" pay is increased, profit is increased, and, of course, costs are decreased. Workers are paid on the basis of the amount of work they can do accurately in a set period of time.

In other words, the individual worker is paid commensurate with his ability. To take care of a re-

sulting discrepancy, day workers are brought up to correspond to the over-all percentage of increased production.

I am in favor of incentive plans if they are sound and workable. I heartily endorse them, and I hope to see the day when they are installed in all plants where it is possible to do so. To my mind, it is a great forward step in industry to recognize by a pay check the differences, the variations in ability of all men.

CASTINGS INSPECTION
And Qualifications of Inspectors

By A. K. Higgins, Metallurgist,
Allis-Chalmers Mfg. Co., Milwaukee, and
A.F.A. Committee on Inspection of Castings

THE study of non-ferrous castings inspection by this Association is not new, but an approach to the subject probably should begin with fundamentals. Thus, a logical beginning might be to define the functions of an inspector and, since inspectors have many duties, such a definition should not be too restrictive.

Certainly the first and most obvious duty of an inspector is to inspect or examine the product of the company in whose foundry he operates. Normally, he must examine products in a critical sense, attempting to separate the usable and satisfactory items from those not suitable for industrial use.

In performing this function, he immediately becomes the representative of the customer even though he is employed by the manufacturer, and at the same time acts as a nagging conscience for the manufacturer even when he is employed by the customer. It might be added that some of us attempt, although unwisely, to satisfy our inspectors as well as our consciences with something less than the best, be it castings or behavior.

What the Inspector Must Know

If the inspector is to function in a critical way, he must know how the customer can be satisfied. He must be able to read blueprints, and know how to use rough measuring tools, so as to determine if castings are dimensionally suitable. He must be sufficiently familiar with castings so as to determine where defects are likely to occur, so that he can detect them rapidly and with certainty.

He must know the needs of the customer and what degree of perfection the customer requires. He must be able to interpret printed specifications and make clear, logical decisions from them. He must be able to examine critically the methods and equipment for testing the quality of metals used. In addition to these abilities, he can work more efficiently if he is able to make use of any equipment available, such as x-ray and pressure testing devices.

Thus far we have considered the inspector in the light of a negative personality, rejecting the unsuitable and allowing almost regretfully, the acceptance of castings he cannot justifiably reject. Such a picture, although seldom warranted, seems to express the views of many foundrymen who have not had a great deal of contact with good inspectors.

Holds Unique Position

The inspector who answers to this description has failed his employer in considerable degree, because actually he is in a unique position to perform other services which might expedite the delivery of usable castings and assist in improving the quality of those castings he is inspecting.

One of the first things an inspector must learn is the nature and cause of castings defects, as well as their probable extent. He should know how to use all facts at his disposal—such as location of the fault, nature of the material, color of surfaces, and methods of casting—in arriving at a proper decision.

With such information before him, he then will know whether or not the defect is transient or accidental in nature (for example, a bit of charcoal not skimmed from a crucible), or whether it is apt to recur when further castings are made using the same equipment. An example of the latter might be a shrink in an isolated boss.

Much can be learned by observation and experience. However, the American Foundrymen's Association has provided and is constantly providing additional material that will serve as a working text on the subject of castings defects.

Most of the information which is marked for inclusion in the forthcoming Inspector's Manual will be found in reports of the Committee on Analysis of Castings Defects, under the A.F.A. Brass and Bronze Division. Additional information on specific metals is contained in chapters of RECOMMENDED PRACTICES FOR SAND CASTING NON-FERROUS ALLOYS, published by A.F.A. in 1944.

Determining Causes of Scrap

Basically, it would seem that determination of cause of scrap is a function of the foundryman rather than the inspector. While this is generally true, in actual practice a number of important exceptions to this rule will occur.

One common exception involves castings which are not source-inspected, although plants of the manufacturer and customer are widely separated. If the foundry is to avoid endless repetition of scrap castings, it is essential that the inspector be able to make a clear, logical explanation of the defects found in machining. Reports on the location and nature of defects can then be transmitted to the foundry by mail or telephone, thus avoiding the delay involved in returning castings.

When possible, the inspector should send a marked print showing the nature, size and location of the defect as well as the degree of perfection required. The location of a defect should be clearly marked when castings are returned to the foundry.

(An interesting example of one method of easily locating defects when two plants are widely separated, is described in an article by A. C. Kalk in this issue. Editor's note.)

As another example of the inspector's importance, a customer's inspector at the foundry can aid the foundry in securing needed changes in design that will facilitate casting. This might be particularly useful in the making of hydraulic castings.

Finally, the inspector frequently

can be of major aid to the foundry in the interpretation of additional data obtained by x-ray or gamma-ray inspection. The cost of these methods is beyond the financial means of the small foundry, but may be available to the customer through the medium of the inspector.

From the foregoing it would seem that the inspector must be a jack-of-all-trades, foundryman, somewhat of a machinist, a scientist, and perhaps a bit of a pattern maker. All these qualifications are desirable for an inspector.

In addition, the inspector should be something of a diplomat, because in most cases the inspector is the customer's most frequent contact with the foundry. The inspector can do more to promote good relations than can almost any other person in the organization.

Inspectors Must Cooperate

Too many inspectors seem to have gained a concept of foundry conditions through some unfortunate newspaper reports on isolated cases of graft and bribery. Such a "chip-on-the-shoulder" attitude can undo a great deal of good will that has been built up by sales and purchasing organizations.

The average foundry personnel is honest and sets a high value on its integrity. If the inspector is sufficiently wise, he will appreciate the reactions of a foundryman who may not have had contacts with inspection, or perhaps has had unhappy contacts. As a consequence, the inspector will make every effort to establish his position as rapidly as possible.

Much of his success depends upon his ability to present a friendly but business-like attitude. Much also depends upon his willingness to discuss causes of scrap and possible methods of salvage with the proper foundry people. Never will he make the mistake of trying to assume any authority for changes in production methods, which properly belong to foundry supervision.

What Inspectors Must Know

To summarize, the qualities most desirable in a foundry inspector might be listed as follows:

(1) He must know the tools of his trade, such as blueprints, measuring equipment and special inspection devices such as x-ray.

(2) He must be sufficiently familiar with foundry methods and conditions as to be able to spot and identify defects.

(3) He must be able to describe those defects to the foundryman in the foundryman's own language.

(4) He must be prompt in reporting causes of trouble, so that defects may be corrected promptly and the production of good castings expedited.

(5) He must have sufficient diplomatic horse-sense to fulfill his functions without friction or misunderstanding.

Inspection Committee Elects New Officers

THE A.F.A. Inspection of Castings Committee held its last meeting of the year May 23 at which time it completed its schedule of preparing sections for the Manual for Casting Inspectors, for publication in AMERICAN FOUNDRYMAN. Chairman Harold W. Warner, Foundry Inspector, Allis Chalmers Mfg. Co., Milwaukee, presided.

In closing the meetings for the year, the committee elected the following officers for the coming year:

Chairman, E. G. Leverenz, Chief Inspector, American Steel Foundries, Indiana Harbor Works, East Chicago, Ind.

Vice-Chairman, H. C. Stone, assistant, Metallurgical Laboratory, Belle City Malleable Iron Co., Racine, Wis.

Secretary, F. L. Bender, Chief Inspector, Chicago Hardware Foundry Co., North Chicago, Ill.

I.B.F. Sends Its Greetings To All A.F.A. Members

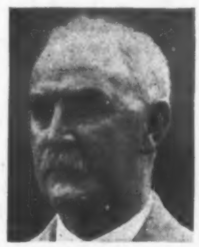
AT the annual meeting of the Institute of British Foundrymen held in London, June 15 and 16, the President and Council forwarded cablegram greetings to the A.F.A. The cablegram was as follows: "The president, council and members of the Institute of British Foundrymen at the annual meeting in London send cordial greetings and good wishes to all members of the American Foundrymen's Association."

News of John Shaw's Death Is Received Here

MEMBERS of A.F.A. who knew John Shaw of England, long one of the foremost of British foundrymen, will be sorry to learn that he died at his home in Sussex, April 30.

According to word received from a friend of the family, Miss Winifred Hague, who had been attending him in late years, Mr. Shaw was forced to evacuate his home in Southsea in 1940 because of air raids, and the last letter received from him was published in the August 1943 issue of AMERICAN FOUNDRYMAN.

Few foundrymen from abroad made and retained as many friends in America as did John Shaw. He was an intensely active member of the British foundry industry and of the Institute of British Foundrymen, serving with the Ministry during



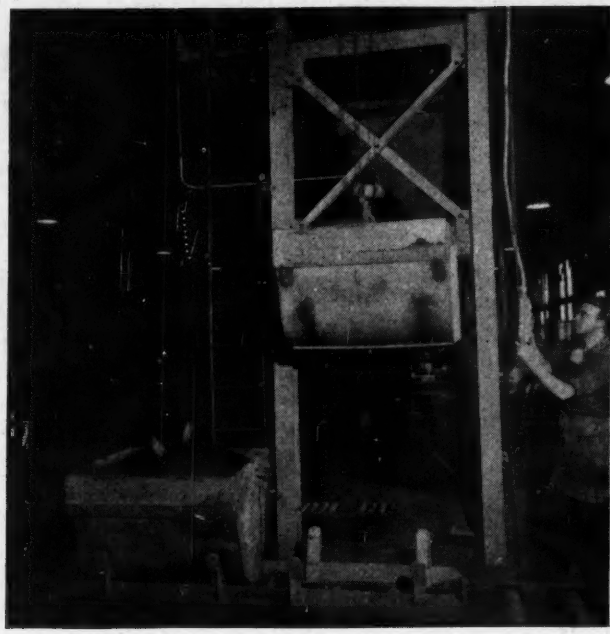
John Shaw

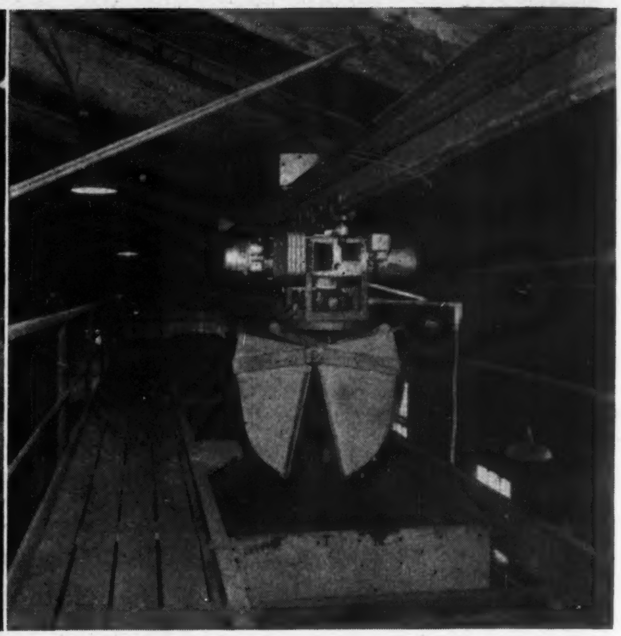
World War I, and contributed frequently to the technical press on foundry subjects thereafter.

Having become acquainted with many American foundrymen through his articles, he attended the 1926 A.F.A. Convention in Detroit, where he was awarded the John A. Penton gold medal of the Association. At that time he also presented the annual exchange paper from the I.B.F., and for many years after that event he carried on personal correspondence with American friends.

Realizing that death was approaching, one of his last requests to Miss Hague was that his friends in this country be notified through the medium of A.F.A.

It is with deep regret that the Association announces the passing of one of the world's most widely known foundry authorities and extends its greatest sympathy.





Handling sand in a small foundry can be done easily with modern equipment.

Synthetic Sand in Non-Ferrous Foundries

By N. J. Dunbeck, Vice-President, Eastern Clay Products, Inc., Eifort, Ohio

THE name synthetic sand is usually applied to sands which are made in the foundry as required, from materials so selected as to best do a particular job. Synthetic sands have not been as widely used in non-ferrous as in ferrous foundries for several reasons.

Many non-ferrous foundries are small and lack the mixing equipment which it is desirable to use with all bond clays, and essential to use with some. It is sometimes difficult to locate conveniently the fine grained sands which are necessary for much non-ferrous work.

Synthetic sands usually require closer control than do naturally bonded sands, and some foundrymen feel that they do not have adequate manpower for the job, in consideration of the quantity of sand used.

It is, however, very true that practically all non-ferrous foundrymen can benefit from the intelligent use of bond clays, even though they may not adopt a full synthetic sand program.

Differences Between Synthetic and Naturally Bonded Sands — These sands are similar in that each consists essentially of sand grains and bond. Most naturally bonded sands in Northern and Eastern United States result from glacial action.

Glacial Origin

The glaciers scoured up sand, rocks and clays of various types which were later set free when the glaciers melted. The coarser materials settled from the transporting water first, then the finer sands and, finally, the clay. When the sand in settling carried with it a substantial amount of clay the result was a naturally bonded sand.

It is obvious that the glaciers were not selective in the material picked up, and that this frequently included feldspar, limestone and other materials which have no place in a good sand.

Thus, out of the vast amount of bonded sand in this country, the only usable materials are those where, by happy chance, the glaciers deposited a combination of sand grains and clay which included a minimum of fluxes and other undesirable materials.

The statement is sometimes made that nature took millions of years to make naturally bonded molding sand, with the implication that this must inevitably result in a high quality product.

There is also the suggestion that in this long period of time nature did a perfect job of coating each grain of sand with clay, and that such a job is superior to what may be accomplished by mere man even with the aid of intensive mixing equipment.

The facts are that balls and agglomerations of clay, with perfectly and imperfectly coated grains of sand, are found in practically all naturally bonded sands. Evidence

• Advantages and disadvantages of naturally bonded and synthetic sands in non-ferrous foundry practice. The author concludes that the use of synthetic sands results in lower sand-handling costs and permits of closer sand control than is possible with naturally bonded sands.

This paper was secured as part of the 1945 "Year-'Round Foundry Congress" and is sponsored by the Brass and Bronze Division of A.F.A.

of this is the fact that mulling a new sand almost invariably increases its strength because it better distributes the clay present.

Assuming that the sand producer makes a careful search for sands containing a minimum of undesirable materials, we can assume that a high grade naturally bonded sand will consist of sand grains, clay and silt. The silt is very finely divided material of a silicious nature which has little or no bonding value.

In making a synthetic sand, we seek a good silica-base sand and a good clay to mix with it. Some of the bank sands are also the result of glacial action. To be a good sand they must be quite free of clay, and this requires a condition of deposition from water which permitted the sand to settle while the clay was carried on farther.

The purer silica sands are older than the glacial period, and usually resulted from the decomposition of sandstones which were transported, classified and sometimes purified in running water. High grade clays are deposited in a similar manner, although clays are also formed in other ways.

Synthetic Sand Application

Thus it is seen that the man who proposes to make a synthetic sand has the odds heavily in his favor in making a high grade molding material. He seeks only a pure sand and a pure clay.

In contrast, the producer of naturally bonded sand seeks to find a high grade sand and a high grade clay, not only in combination but also in the proportions he desires and without the inclusion of undesirable minerals.

All such naturally occurring combinations are variable, and it is common practice to mix sands in arriving at a desired product. The difficulty in maintaining uniformity when dealing with so many variables is obvious.

A. Full Synthetic Sand Program —(a) Selection of Sand Grain—In a full synthetic sand program, we plan to make our sand from silica sand and clay. We must locate a silica sand or bank sand of such fineness as to give the finish we require, along with safe permeability.

This new silica sand may be mixed with clay and added in the foundry exactly as is naturally bonded sand; or the sand and clay may be added individually at the shake-out or on the heaps. Sometimes, the materials are added in the facing sand and no additions may then be necessary to system sand or heap sand.

In most synthetic sand programs it is desirable to allow the burned core sand to mix with the used molding sand at the shake-out. The fineness of the core sand thus influences the selection of the base silica sand. If the core sand is rather coarse, a finer base sand may be required, or the reverse.

Synthetic Sand Durability

Burned core sand is an excellent base sand because the somewhat roughened grains accept bond clay readily. The usual procedure is for the non-ferrous foundryman to gradually add synthetic sand to his present sand, making the change a gradual one. In an extreme case, he might discard all of his old sand and start with a new synthetic sand composed of bank sand and bond clay.

The strength of this sand would burn out slowly, as synthetic sands have from three to six times the durability and life of most naturally bonded sands. A very small amount of new material would, therefore, be necessary as a daily addition. The foundryman can expect that his synthetic sand cost per ton of castings will be from one-third to one-sixth the cost of using naturally bonded sands.

(b) Selection of Clay—The choice of clay will usually lie between a fire clay and a bentonite. Each type of clay has definite physical characteristics and produces a notably different type of sand.

Two to three parts of fire clay must be used to give the same green strength as one part of bentonite. This results in definitely lower permeability.

This is a disadvantage when the readily available base sands are fine grained and low in permeability. It may be of advantage when the only available base sands are rather

View of a 25-ton sand storage tank and a 4 cubic foot muller.

coarse, in which case the greater bulk of fire clay smooths the sand and improves the finish.

Fire clays require intensive mixing for dependably good results. They have a wider moisture range than the bentonite and are easier to control. They are more refractory, giving a higher sintering point. They have longer life or durability than the bentonites and this, combined with low initial cost, makes them more economical than any other type of clay.

Western Bentonite

This type of clay is characterized by a combination of high green strength and high permeability. Since a smaller quantity may be used than fire clay, a safe permeability will still result even if a finer grain sand is used. It requires intensive mixing for good results. It is workable at a lower moisture content than fire clay.

Having higher dry strength than any other type of clay, it would logically be chosen, either used straight or in combination with other clays, for making heavy nonferrous castings or for those with such gating as to create cutting and erosion problems.

This same dry strength results in the sand baking rather hard in flasks, creating a difficult shake-out and lumpy sand which is sometimes difficult to retemper and recondition. Western bentonite should not be used where the design of casting or type of metal is such as to create danger of cracked castings.

Southern Bentonite

Southern bentonite is higher in green strength and permeability than western bentonite. It combines these values with moderate dry strength. It gives easier shake-out and fewer lumps in sand than any other type of bond clay.

Southern bentonite makes a sand of high flowability, that is, one which rams easily to a hard surface, thus producing excellent finish. Southern bentonite is also unusual in that it mixes readily with sand, even without an intensive mixer, and is, therefore, the only bond clay which may be used with safety by foundries which do not have mechanical mixing equipment.

Thus it is seen that the clay should be carefully selected to fit the individual foundry condition. Failure to so select the clay based on the job to be done, and the effort to make any one clay fit all conditions, are reasons why synthetic sand has sometimes been abandoned, although it should have had application in the particular foundry.

Relative Clay Values

The relative values of clays are given in Table 1. It should be kept in mind that combinations of clays frequently give better results than any individual clay.

B. Semi-Synthetic Sand Program—Foundrymen say that they are using semi-synthetic sand when they are using part synthetic sand and part naturally bonded sand. It may be that a local natural sand will be particularly well suited to a particular job, and the foundryman will desire to continue using it.

At the same time, he may realize the superiority of synthetic sand for another type of work. And, sometimes, a mixture of natural and synthetic sands may give excellent results. For instance, the addition of a small amount of natural sand to a synthetic sand will reduce the rate of drying out.

It is sometimes the case that good base sands of the proper grain size are not locally available. It may then be cheaper to buy the best available low bonded molding sand and bring it to proper working condition by the addition of bond clay. The clay may be mulled with the sand or added in any other convenient manner.

Fire Clay Additions

Any particular sand might be strengthened and made more refractory by the addition of fire clay; its dry strength might be increased by the addition of western bentonite; or its flowability and workability might be improved by the addition of southern bentonite. It is important to remember that the clay has far more effect on the properties of the finished sand mixture than does the sand grains.

C. Rebonding Program — Some foundries continue to use satisfactory naturally bonded sands and use bond clays only to extend the life of the sand. It is very costly to use sand until its strength has been burned out and then discard it. The grain may be perfectly good and require only the addition of bond clay to again make it workable.

In this method, a small amount of clay (1) may be added to the regular facing sand mixture; (2) added on top of the natural sand at the shake-out; (3) mixed with the new natural sand before it is added; or (4) a small amount of clay might be placed on top each mold before the shake-out.

Some naturally bonded sands, such as Albany, are well liked for their grain distribution, but are frequently unsatisfactory and expensive in use because of their low strength. It is a very simple matter to increase their strength to good workable levels, with no appreciable effect on permeability, by the addition of small amounts of bond clay.

Mold Production

This saves money by extending the life of the sand and, sometimes much more money by increasing production. A molder is able to pound out many more molds per hour from a flowable, strong, open sand than from a weak, friable sand which must be babied along and which may cause frequent mold losses from drops.

Such weak naturally bonded sands, when used without the addition of clay, are usually run very wet in order to get workability, which much increases the danger of scrap from the gas produced. The amount of gas produced from various sands is given in Table 2.

Bond clay is of particular economy in bonding burnt core sand

Table 1

RELATIVE VALUES OF BOND CLAYS
(MICHIGAN CITY SAND MULLED WITH CLAY AS SHOWN)

Bond — Clay	Bond — Per Cent	Tempering Water, per cent	Green Compressive Strength, psi.	Dry Compressive Strength, psi.	Green Permeability	Hot Strength, 2000° F., psi.
Fire Clay	12½	4½	9.27	38.3	100	325
Southern bentonite	4	2½	9.19	31.0	175	25
Western bentonite	5	2½	8.69	53.1	171	490

Table 2

GAS EVOLUTION FROM VARIOUS SANDS

Sand	*Tempering Water for Proper Workability, per cent*	*Gas Evolved at 1800° F./Cu. Ft. Sand, cu. ft.*
Ottawa silica sand, 95 per cent Western bentonite, 5 per cent	2.5	232.3
New Albany sand	4.8	502.4
New Ohio sand	7.8	778.3

into a molding mixture, since the sand otherwise is an item of expense in disposal. Such sand usually has good flowability and permeability, while strength may be regulated to suit any job. The cost of hauling burned sand to a mixer to be rebonded is no greater than the cost of hauling it to a dump.

The cost of hauling the rebonded sand to the point of use is no greater than the cost of hauling in an equal amount of new sand. In fact, the cost may be less, since a synthetic sand can be prepared of twice the strength of natural sand, thus halving the quantity required.

Rebonded Sand Costs

A gloomy picture is sometimes presented to the smaller non-ferrous foundryman, who is told that to rebond sand he must haul the materials to and fro in his foundry, thus creating a prohibitive expense.

As seen from the foregoing, these hauling costs are usually lower with rebonded sand than with natural sand, and the actual cost of the rebonded sand is made up only of materials and mixing costs.

The total cost of a sand bonded to the strength of new naturally bonded sand will usually be less than $1.00 per ton, and this may be compared to the delivered cost of new natural sand. The cost of sand rebonded only to normal workable strength is, of course, much lower.

Advantages of Naturally Bonded Sands—Such sands are usable with a minimum of equipment, or with none at all. They retain moisture better than synthetic sands and are easier to patch and repair. They are usable over a wider moisture range than synthetic sands.

Disadvantages of Naturally Bonded Sands—Being a naturally occurring product, naturally bonded sands are variable in quality. Large quantities of materials must be handled and stored for winter. They frequently contain fluxes and impurities, and are lower in refractory value than synthetic sands.

Silt in Naturally Bonded Sands

Because they contain fine silt they are workable only at much higher moisture contents than is synthetic sand, and are definitely less safe in use. They are costly in use because they are discarded when their strength has been burned out, although the grain may still be perfectly good, and require only the addition of bond clay to again make them workable.

Disadvantages of Synthetic Sands—Since they are workable at a low moisture content, the loss of water by evaporation is more serious, and synthetic sands are said to dry out faster than naturally bonded sands. Because of their high flowability they are likewise more brittle than naturally bonded sands, and are more difficult to patch. They require more mixing equipment than the naturally bonded product.

Advantages of Synthetic Sand—The two outstanding advantages of synthetic sand are ease of control and economy. Since they are made from individual components selected and blended by the foundryman under his own direction, they can be made exactly as required and varied when necessary. By constantly re-using the same sand and by reclaiming burnt core sand, the cost of molding materials is held to a very low figure.

Summary

No attempt has been made to give specific sand mixtures because of the great variety of work made in non-ferrous foundries. Also, no attempt has been made to give physical characteristics of sands for various metals because the subject is so thoroughly and ably covered in the A.F.A. *"Recommended Practices for the Sand Casting of Non-Ferrous Alloys"* (published in 1944).

Synthetic sand is cheaper and permits closer control than naturally bonded sands. One car of bond clay will replace about 20 cars of naturally bonded sand, thus reducing the volume of materials handled. Closer control means definitely lower scrap in synthetic sand foundries.

Since southern bentonite can be used without intensive mixing equipment, it is now possible for any non-ferrous foundryman to get some of the advantages of bond clay in extending the life of his sands, producing sands of better working values and definitely decreasing his costs.

Specifically, the non-ferrous foundryman needs a fine grained sand, and that usually means constant danger from blows when using the high moisture content necessary with naturally bonded sands. In using synthetic sands, he creates far less gas and thus solves one of his major sand problems.

Book Review

Damping Capacity: A General Survey of Existing Information, by Prof. F. C. Thompson, British Non-Ferrous Metals Research Association Report R.R.A. 657. August, 1944. 37 pp. 21 figs. Price 3s. 6d. Obtainable from the British Non-Ferrous Metals Research Association, Euston Street, London, N.W.1.

At the request of the B.N.F.M.R.A. Main Research Committee, Professor Thompson has here prepared a correlated survey of the present knowledge of the fundamentals of damping capacity such as its metallurgical and mechanical significance and the validity of present methods of determining it. Suggestions are made of directions in which future experimental work might prove fruitful.

The survey was prepared to guide the B.N.F.M.R.A. Main Research Committee in considering the desirability of initiating research on the subject. No attempt has been made in it to produce a compilation of numerical data.

There is a bibliography of 58 references supplementing existing bibliographies to which reference is made.

Special Brick Shapes for
CUPOLA REFRACTORIES

By H. M. Hazeltine,
Fremont Foundry Co., Fremont, Ohio

• Over a period of years, considerable difficulty had been experienced in cupola operations at the author's foundry because of tap hole, trough, slagging spout and cupola well refractory failures. The use of fire brick shapes, specially designed for particular applications, eliminated the refractory troubles and made possible substantial operating economies.

A 9 in. straight fire brick with a ¾-in. hole located 2 in. from the end was used for the tap hole. This brick was placed in a vertical position and held with stiff bott mud made of fireclay, and this formed the breast.

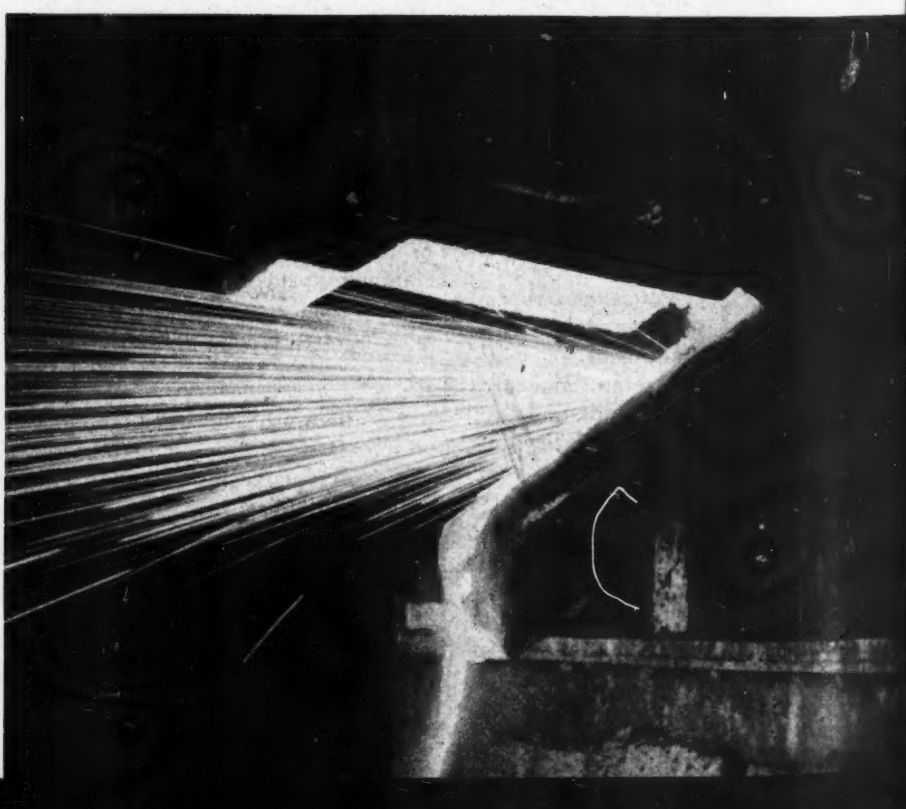
Approximately one hour of more or less skilled labor was required for the proper installation of this tap hole brick. The whole set-up was never very satisfactory at the best, and on long heats would cause more or less trouble.

Twelve years ago a wooden pattern that embodied the tap hole brick and the breast all in one piece was made up. This pattern was submitted to a fire brick supplier with the request that it be duplicated in a fire brick shape. Thirty days later ten samples were received, and they were perfect in every detail. The ¾-in. hole was just right. The quality of the brick was exceptionally good, and this tap hole brick has been used continuously since that time with no trouble of any kind.

It has definitely proved its merits in many ways. It is safe and economical; it can be installed in a few minutes and requires no special skill. It is almost indestructible. This brick is held in place with plastic ramming refractory.

The cupolas are equipped with a steel trough 4 ft. long, 12 in. wide and 10 in. high. This trough was lined with fire brick and daubing mud, forming a runway for the molten metal to flow from the cupola into a receptacle. The trough lining was not very satisfactory, as trouble was experienced on long heats. Each day the trough had to be chipped out and repaired, an expensive operation, so the question was asked, "Why could not this be a brick tile of given length and width—one that could be laid in lengths and form the trough with the proper contour, thus making a valley for the molten metal to flow from the cupola?" The matter was referred to a fire brick supplier, and a special trough tile 13 in. long, 7 in. wide and 7 in. high was made. These are laid in four lengths, bedded in soft, plastic fire clay, and held in place with 9 in. straight brick on the sides. It requires just a few minutes to build the entire trough, and anyone can do this work as there is nothing complicated about it. The life of these trough tile in continuous use will vary from 4 to 6 months, depending upon the care taken with them. To prolong the life of these trough tile, a ½-in. layer of plastic ramming refractory rammed in the bottom contour of the tile is used. It takes just a few minutes each day to do this, and it protects the joints where the tile are placed together. It is surprising how easily this layer of plastic ramming refractory can be scaled off the

Fig. 1—Cupola slag spout showing specially designed refractory cover in raised position.



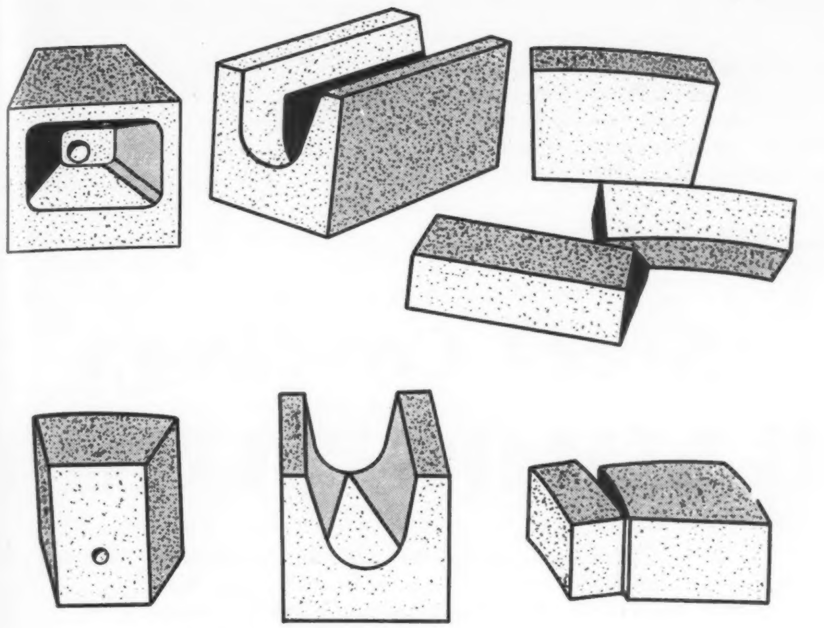


Fig. 2—Sketches of specially designed cupola refractory bricks.

next morning after the heat. This leaves a clean trough, free of all slag that had formed during the heat. When the factors of time saved, safety, convenience and durability are considered, the special trough tile proves to be a profitable investment.

The next brick of special design to be made up was a 72x77 circle brick, which is used as a face brick in the well of the cupola below the tuyeres. Previously, 1¼-in. splits placed against the shell of the cupola, and then 72x84 cupola blocks, which were faced off with more 1¼-in. splits, had been used. The life of this facing was about 2 weeks, and it would then have to be replaced. Quite often the slag and iron had destroyed these splits, and removing them would cause damage to the blocks, making an uneven contour in the lining. In relining the cupola every 6 months, the entire base of the well had to be replaced, causing extra work and expense.

Since using the new 72x77 curved brick for facing, all of this previous trouble has been eliminated. These brick will last in continuous service for from 6 to 8 weeks. To remove and replace these brick requires only 30 minutes, and they preserve the main base of the well for an indefinite period.

The author wishes to state here that "a refractory is only as good as the bond that holds it." Slag and molten metal will attack the joints and, unless care is used in selecting a good bonding material, the life of the refractory will be nil.

Cupola Slag Spout

A cast iron cover was used for the slag spout. The entire cover was of gray iron and the life would vary considerably. The top of the cover would burn through, and this would occur during the heat, causing much delay and inconvenience. The trouble was overcome by having a cover made with an open top and a special brick tile to fit the opening. This fire brick tile cover has proved to be a success in every way. The life of these covers is about 6 weeks. They are held in place with a steel bar fitted on stud bolts on each end of the cast frame and secured with wing nuts, which has proved to be an ideal arrangement. The cover has eliminated all of the sparks and mineral wool coming from the slag hole. To replace these cover tile takes only 60 seconds.

All of these brick are of special design, each has its own function and they have proved to be far superior to anything previously used.

This paper was secured as part of the Program for the 1945 "Year-'Round Foundry Congress" and is sponsored by the Refractories Committee of A.F.A.

Refractories Committee Gives Out Practical Ideas

By Chairman C. E. Bales,
The Ironton Fire Brick Co., Ironton, O.

REALIZING the importance of refractories in foundry practice, the Refractories Committee has been devoting its efforts to formulating ideas that would be interesting and of considerable practical value to many foundrymen.

During the war period many foundrymen have been called upon to produce electric steel castings, although it was entirely new to many of them. They had to learn the "hard way" and refractories was just one of their problems. Naturally they have accumulated a great deal of information on the performance of refractories in small electric furnaces, and in ladles handling this steel. Some new refractory products were developed which enabled these foundrymen to increase the service life from their furnaces and ladles. The committee expects to have two or three papers written by experienced operating men published in the "AMERICAN FOUNDRYMAN" on refractory problems in electric steel foundries.

Magnesium Assn. Appoints Aincham as Committeeman

HOWARD AINCHAM, Hills McCanna Co., Chicago, has been appointed official representative for The Magnesium Association, New York, on the A.F.A. Cost Committee. The A.F.A. is gratified at this cooperation. The A.F.A. Cost Committee is unique in that it has official representation from the various trade associations, namely, Non-Ferrous Founders' Society, Gray Iron Founders' Society, Malleable Founders' Society and Steel Founders' Society.

The Cost Committee's chief objective is interesting all foundries in knowing their costs, and annually holds meetings to discuss this subject. The Chairman of the A.F.A. Cost Committee is Ralph L. Lee, Comptroller, Grede Foundries Inc., Milwaukee, Wis.

Other societies interested in placing men on this committee should contact R. E. Kennedy, Secretary, American Foundrymen's Association, 222 W. Adams, Chicago 6.

• This paper was secured as part of the 1945 "Year-'Round Foundry Congress" and is sponsored by the Steel Division. Part I appeared in the May issue of "American Foundryman" and reviewed the general principles of radiography. Part II discusses the application of these principles in the foundry.

Steel Castings RADIOGRAPHY

By E. L. LaGrelius, Supervising Metallurgist, Research Lab., American Steel Foundries, East Chicago, Ind., and C. W. Stephens, Foreman, X-Ray Department, American Steel Foundries, Granite City, Ill.

THE company with which the authors are associated has two one-million volt X-ray machines in its Granite City plant.

An exterior view of the X-ray building of this plant is shown in Fig. 1. It consists of a loading room, two separate X-ray set-up rooms, two control rooms, one dark room, and an office.

The loading room (Fig. 2), which is 31 x 20 ft., has a 3-ton overhead crane and leads into both set-up rooms. In this room castings are transferred to trailers and moved into the set-up rooms.

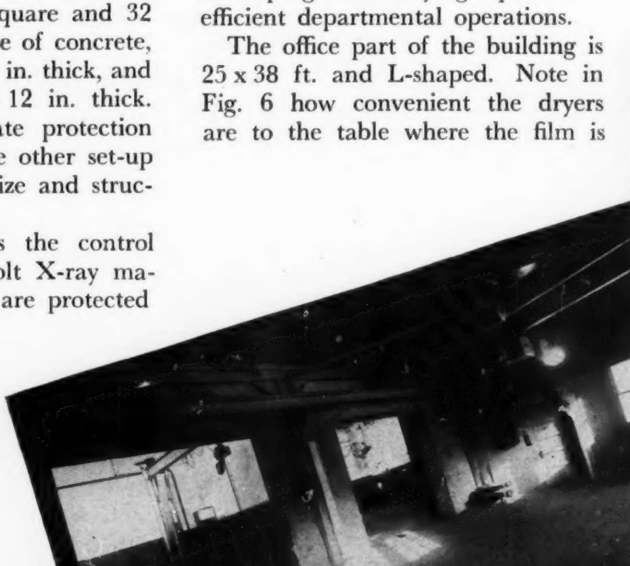
Figure 3 shows one of the set-up rooms, displaying the X-ray head. This room is 25 ft. square and 32 ft. high. The walls are of concrete, the lower 16 ft. are 18 in. thick, and the upper 16 ft. are 12 in. thick. This provides adequate protection from the X-rays. The other set-up room is identical in size and structure.

Figure 4 illustrates the control panel of a million volt X-ray machine. The operators are protected by a 36 in. concrete wall while operating this panel.

The dark room, shown in Fig. 5, is 21 x 24 ft. and L-shaped. There are two separate developing units, one horizontal dryer and three vertical dryers, which provide ample developing and drying space for efficient departmental operations.

The office part of the building is 25 x 38 ft. and L-shaped. Note in Fig. 6 how convenient the dryers are to the table where the film is assembled. The three doors behind the girls lead to the dryers.

The other part of the office is used for studying film (Fig. 7). Note the four-panel illuminator used for viewing several films at once. This arrangement is convenient for



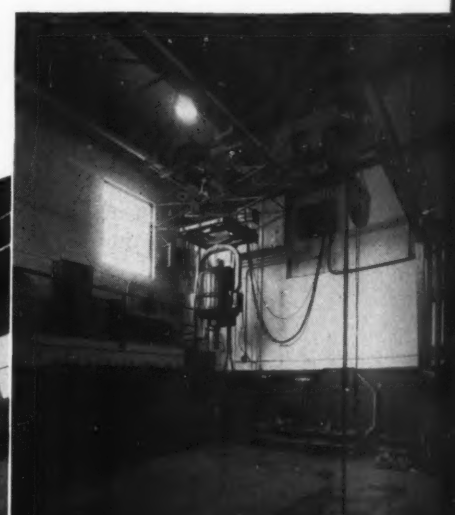


Fig. 1—Exterior view of X-ray building. Fig. 2—Loading room where castings are placed on trailers for transport into set-up rooms. Fig. 3—An X-ray set-up room equipped with a one-million volt X-ray machine.

comparing like positions on different castings.

At this plant the two one-million volt X-ray machines are used exclusively in two important fields: (1) In the developing of foundry technique in the production of steel castings, and (2) in the non-destructive inspection of steel castings.

In developing foundry technique, sample castings are poured and X-rayed in their entirety. The films are inspected by the X-ray department and possible comparisons are made. These, along with the readings and findings, are reported to the Management and Planning Committee. (The Management and Planning Committee consists of the Superintendents of the Foundry, Inspection, Core Room, Pattern Shop and X-ray departments.)

The films showing defects, or unsatisfactory areas, are reviewed and discussed. The best results have been obtained by placing the picture (the film) of the unsatisfactory areas on the casting as it was originally X-rayed. This leaves no room for doubt or misunderstandings. Plans to eliminate undesirable conditions are agreed upon. Thus, in a short time, the casting has been inspected, and changes in technique or design to eliminate defects in unsatisfactory areas may be made.

A splendid example of this X-ray procedure may be illustrated in the development of one casting. The specification on this casting called for radiography. One casting was poured for a sample and X-ray proved the casting to be unsatisfactory and that a number of changes would be necessary. Then changes were made by members of the Management and Planning Committee.

In re-sampling the pattern, four castings were poured, each having a different gate and riser. Each casting was completely X-rayed. The films were compared, area for area, to determine the best method. After selecting what was thought to be the best combination of practices or techniques, two more castings were poured. These two castings were found to be greatly improved. Production was started and the first casting was X-rayed and found to be satisfactory.

Beginning with Fig. 8, some sample castings are shown which have been improved due to the X-ray studies made.

Figure 8 shows an area of a sample casting with clear indications of a dirt and gas condition which had to be corrected.

Through the efforts of the committee a suggestion was made to move the riser to a new position, and as a result a sound casting was produced (Fig. 9).

An example of serious shrinkage and dirt present in a machined area is shown in Fig. 10.

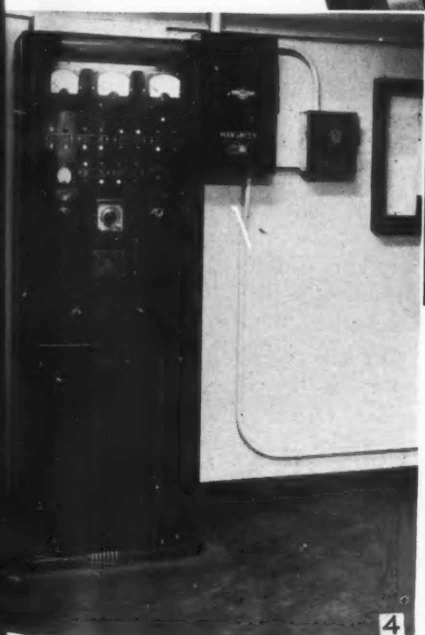
Figure 11 shows the same machined area in a later casting after a riser had been added. This casting was X-rayed after a riser had been burned off, and the majority of defects present are on the surface.

Considerable shrinkage can be seen in the 2 in. X-rayed section shown in Fig. 12.

The same area in Fig. 13 reveals no shrinkage due to the following changes: At both ends, where the serious shrinkage had been present, the metal was reduced to $1\frac{1}{2}$ in. due to a drawing revision. Then by adding a riser in the center of the two shrink voids it was possible to eliminate the shrinkage.

A severe shrinkage condition can be seen in Fig. 14. This defect was found in a 3-in. section around a lifting lug.

After a feeder, running from the riser, had been added, a sound casting was produced (Fig. 15). The



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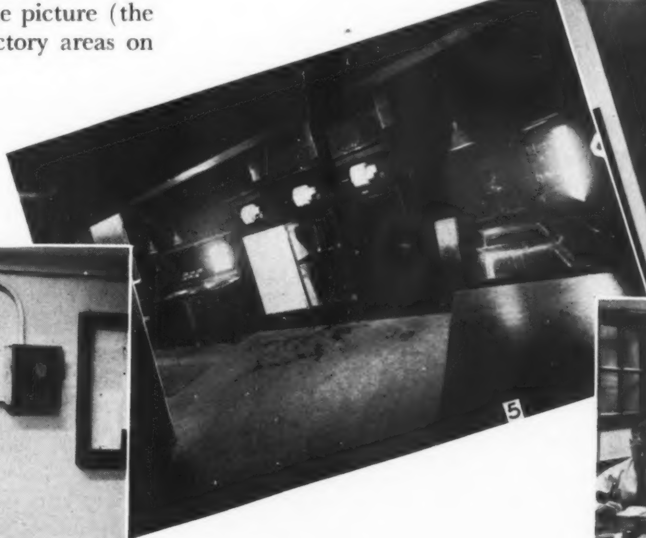

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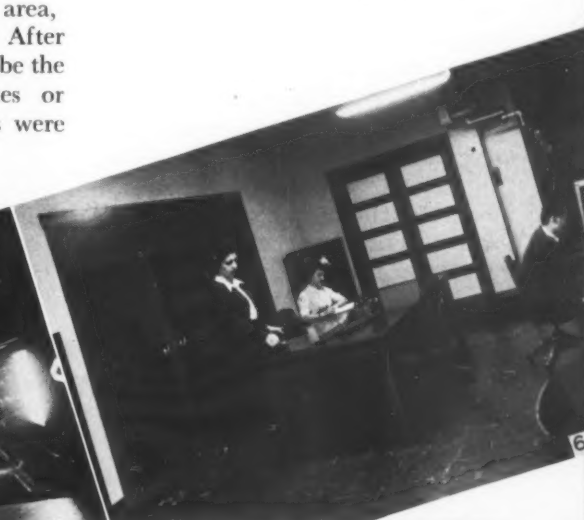

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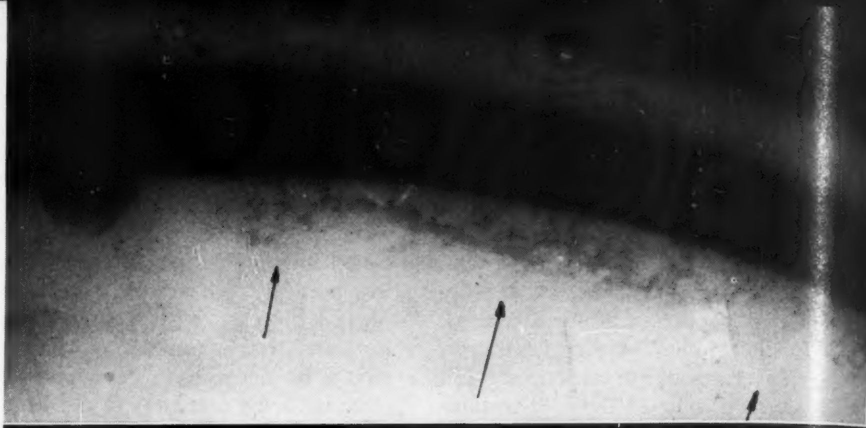
Fig. 4—Control panel of million-volt X-ray machine. Fig. 5—View of dark room showing developing units and dryers. Fig. 6—Assembling the X-ray film. Fig. 7—Four-panel illuminator for simultaneous viewing.

marred sections are surface burns showing where the feeder was burned off.

In all of the above cases the committee played a prominent part in remedying the defects found in the sample castings. Cooperation between all members means much in the saving of time, labor and money.

After the practice was developed, a spot check was made on every 25 castings. In this spot check, two areas were found to have developed serious trouble. Therefore, some minor changes were made and the castings checked by X-ray to determine if satisfactory. Since that time approximately every 25th casting has been checked and only a few minor changes have been necessary.

In the development procedure just described, castings are sometimes sectioned as a supplement to X-ray. In normal X-ray technique only two dimensions are shown. Sectioning will give the third dimension and the average foundryman will obtain a clearer conception of the defect.



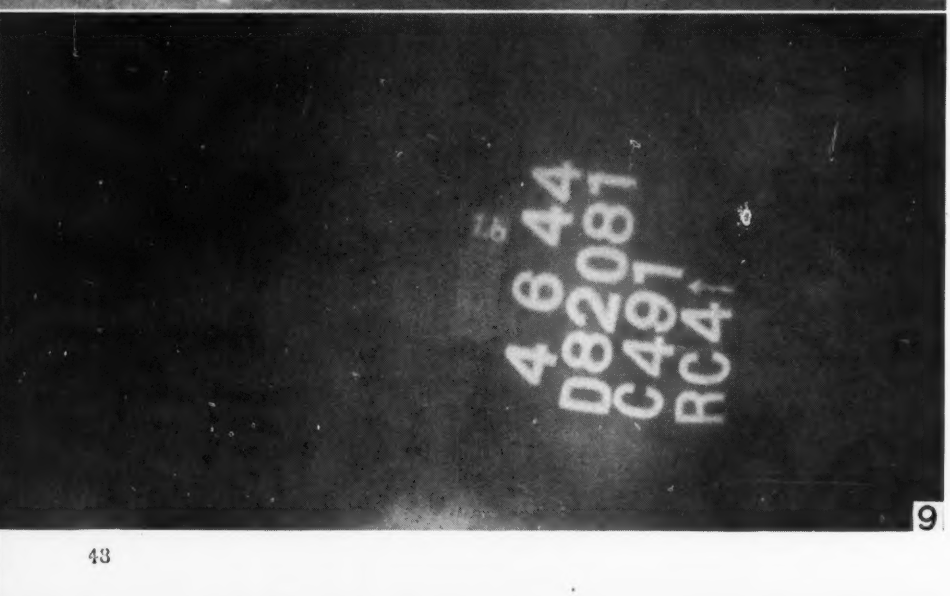


Fig. 8—Defects seen in a casting through the use of X-ray. Fig. 9—Improved area following repositioning of riser. Fig. 10—Serious shrinkage and dirt in a machined area. Fig. 11—The same machined area after a riser had been removed. (Reduced one-fourth for reproduction.)

Sectioning also may reveal the reason for the defect, whereas, in some cases, X-ray would not. It should be stressed, however, that sectioning is used only as an occasional supplement to X-ray in this plant. X-ray, as compared to sectioning, is considered to be far superior in that it is faster and is non-destructive.

On one occasion, shrinkage was found to be present in a $1\frac{1}{2}$-in. section immediately below a heavier section of approximately $3\frac{1}{2}$ in. X-ray showed this defect present in all current castings. The shrinkage is indicated by arrows in Fig. 16. External chills were used in an attempt at correction.

Checking this practice with X-ray disclosed the fact that the shrinkage had not been eliminated but had moved into the heavier section below (Fig. 17). Chills were then added in the heavy section below, in an endeavor to secure equal rates of cooling and equal solidification. This method of chilling did eliminate the shrinkage (Fig. 18).

In Fig. 19 shrinkage is indicated

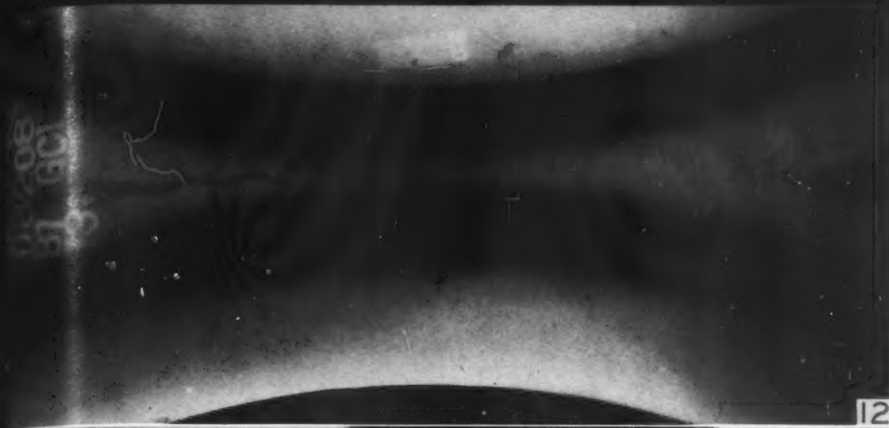


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Fig. 12—A 2-in. section with considerable shrinkage. Fig. 13—The same area following a change in design. Fig. 14—Severe shrinkage in a 3-in. section around a lifting lug. Fig. 15—The addition of a feeder produced a sound casting. (Reduced one-fourth for reproduction.)

in a thin and thick adjacent area where holes are to be drilled in the two slots immediately above the heavy section.

External chills were used on the radius of the heavy and thin section, as shown in Fig. 20, but the chills did not remedy the situation and shrinkage is still present.

In the second attempt "bed-in" chills were added in the slots above the heavy section. The chills in the thin section below were omitted and a cracking strip was added in the radius. The shrinkage was not eliminated but moved down into a machined flange (Fig. 21).

The use of "bed-in" chills and a cracking strip (one chill left in slot) and an added external chill in the radius along the machined flange finally cleared up the area, as shown in Fig. 22.

In the foregoing instances, the X-ray made a thorough picture, not merely of the shrinkage but of the surrounding area as well. The first attempts at chilling were ineffectual, as the X-ray disclosed. Instead of eliminating the condition, chilling had moved the shrinkage down into the heavy sections. The pictures showed the need of chills in the heavy sections. This was followed out and additional X-rays disclosed that the trouble had been eliminated.

In comparison to sectioning, this method was faster by days. It was more thorough in that a perfect picture was obtained, not only of the defect but also of the surrounding area, which proved helpful in that the first attempts at chilling had not been misleading.

Shrinkage had not been eliminated, but moved to another area. The X-ray not only pointed out the error but showed the proper places to chill. Then, too, X-ray was cheaper in that all castings were saved, whereas they would have been destroyed in sectioning.

X-ray pictures, because of their thoroughness, are very impressionable. Pictures which show so clearly the actual results of our own efforts

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Fig. 16—X-ray reveals the presence of shrinkage in a light section of a casting. Fig. 17—External chills used drives shrinkage, shown in Fig. 16, from beneath heavy section into the heavier section below. Fig. 18—Chills added in the heavy section below, tending to equalize solidification rates, produce a shrink-free casting. (Fig. 16 reduced one-fourth, Figs. 17 and 18 reduced one-fifth for reproduction.)

are not easily forgotten. On the contrary, they are most readily catalogued and filed in our minds for future reference. For instance, several months after the chilling episode of the thin and thick sections of the previously mentioned castings, a new pattern was received. One side wall was approximately 1½ in. thick, with eight bosses of 2-in. diameter and approximately 3-in. thickness.

X-ray disclosed shrinkage above all the bosses (Fig. 23). The foundry superintendent viewed the film. Immediately to mind came the pictures of previous chilling experiments. The bosses were bleeding metal from the thin sections, and external chills were placed on the bosses. X-ray proved that the chills eliminated the shrinkage (Fig. 24).

Through the X-ray a tremendous amount of work on riser practice has been possible. The placing of a complete picture of the interior of a casting before the Planning Committee is a direct challenge. Either the casting has shrinkage and needs additional risers, or some cer-

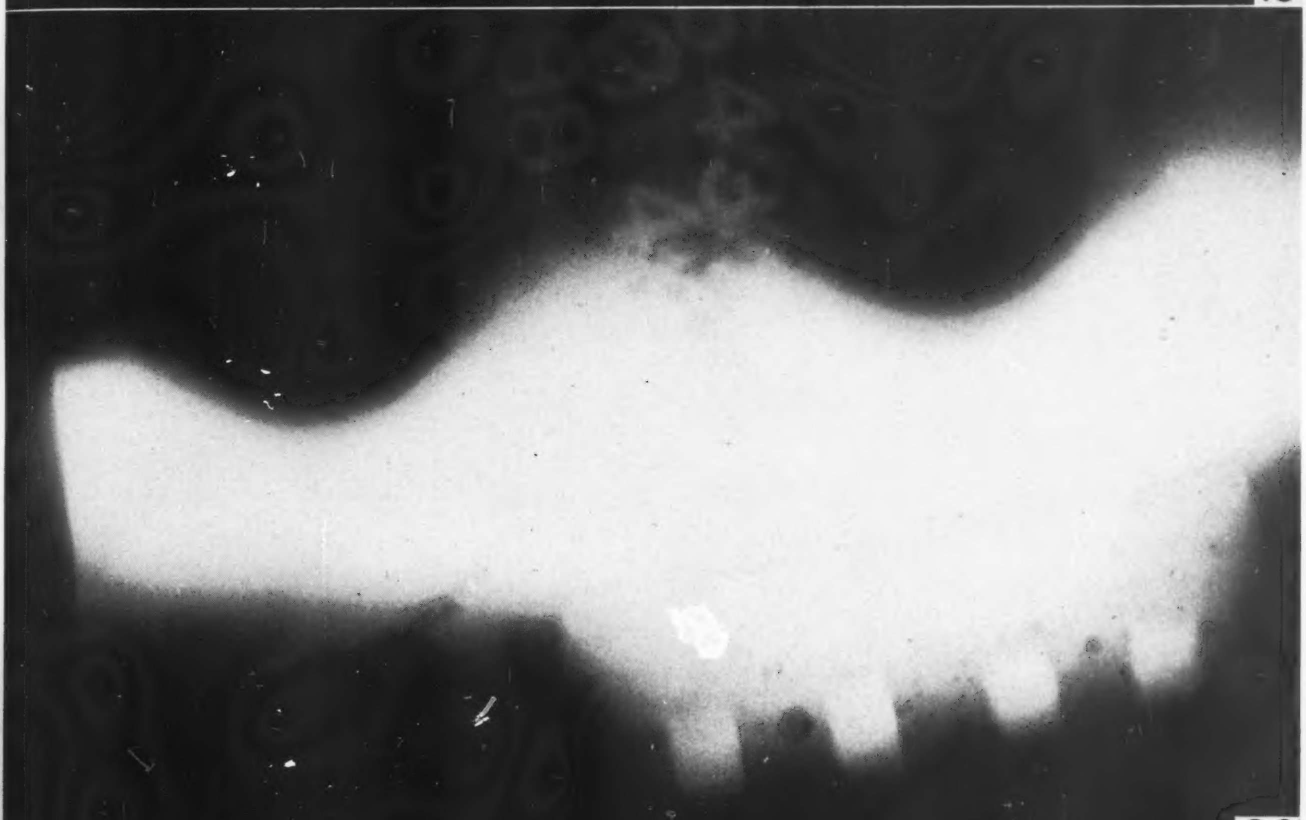


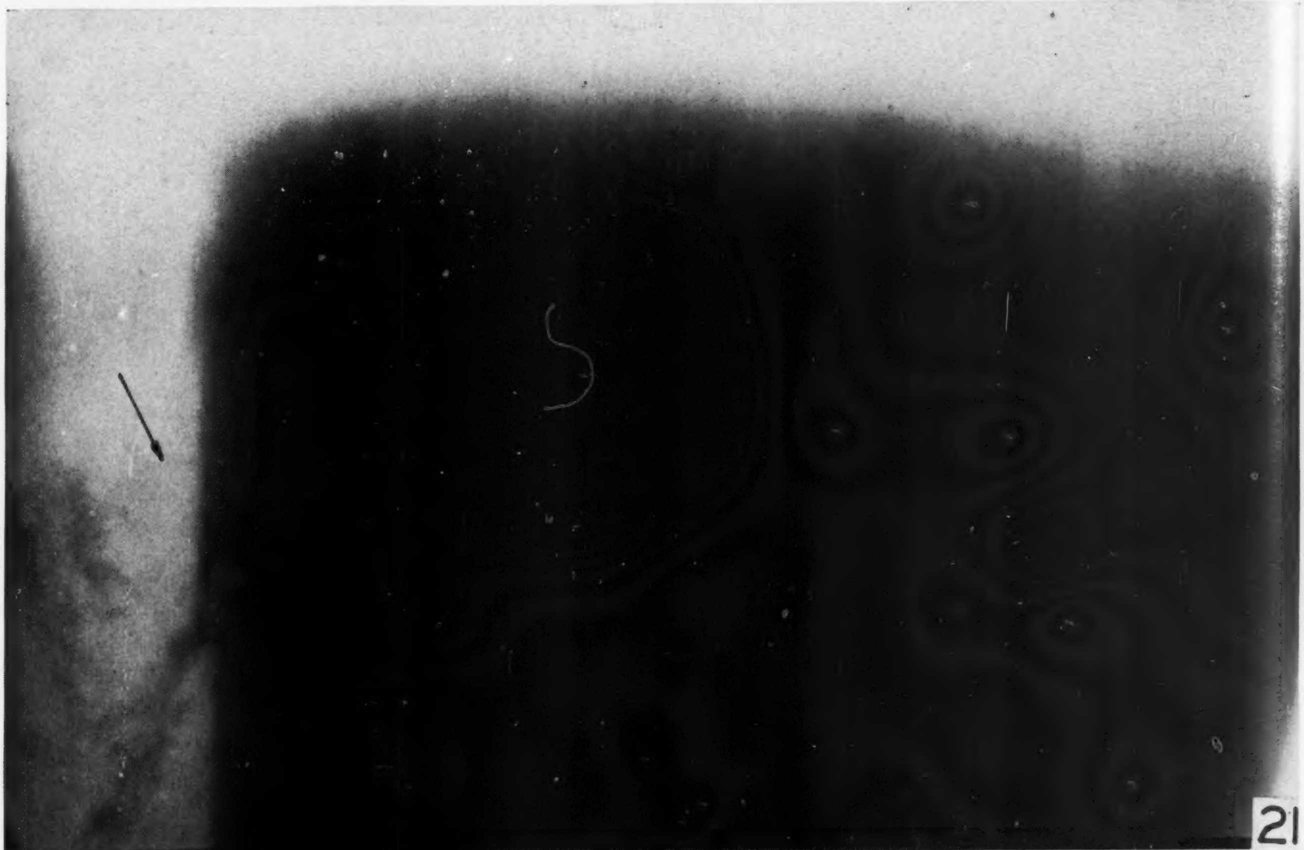
Fig. 19—Shrinkage in a thin and thick adjacent area. Fig. 20—Use of external chills on the radius fails to clear up the condition. (Reduced slightly for reproduction.)

tain riser or risers should be increased in size. Possibly, the casting is solid throughout and risers may be reduced and even eliminated.

The speed with which results have been obtained through the X-ray has made possible the great number of experiments which have been run. Only a small fraction of these experiments would have been attempted had it not been for the X-ray. Through the use of the X-ray, risers have added, relocated, reduced and even eliminated on many patterns, which in turn has made it possible to produce better castings at lower cost.

Some risers are now being X-rayed instead of sectioned, and the results are promising. Risers of up to 7-in. diameter have been X-rayed and good pictures secured. It takes approximately 45 min. to X-ray a riser 7 in. in diameter.

Risers have been X-rayed, then



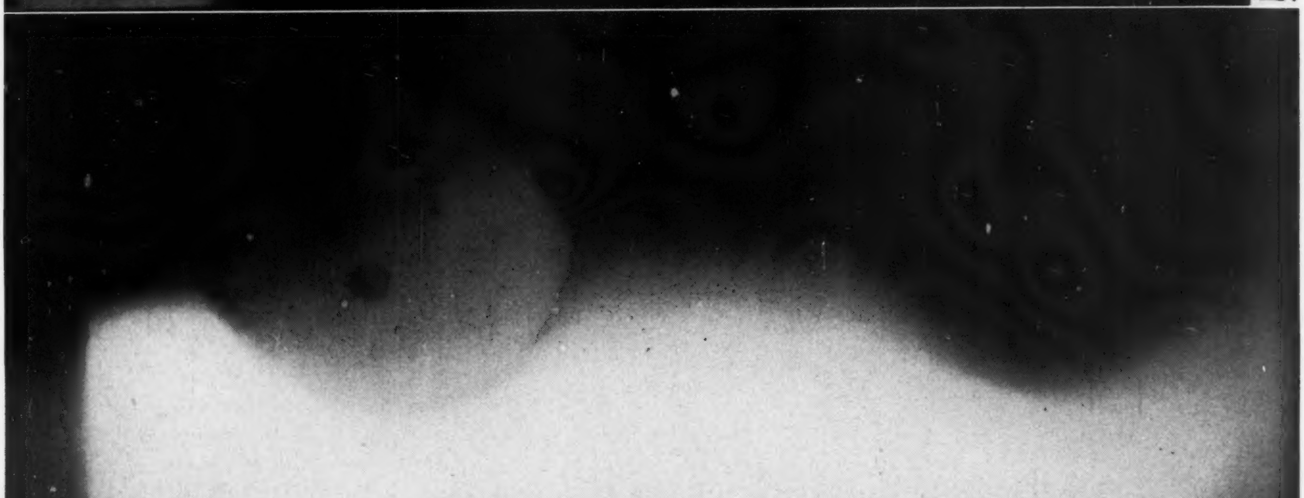
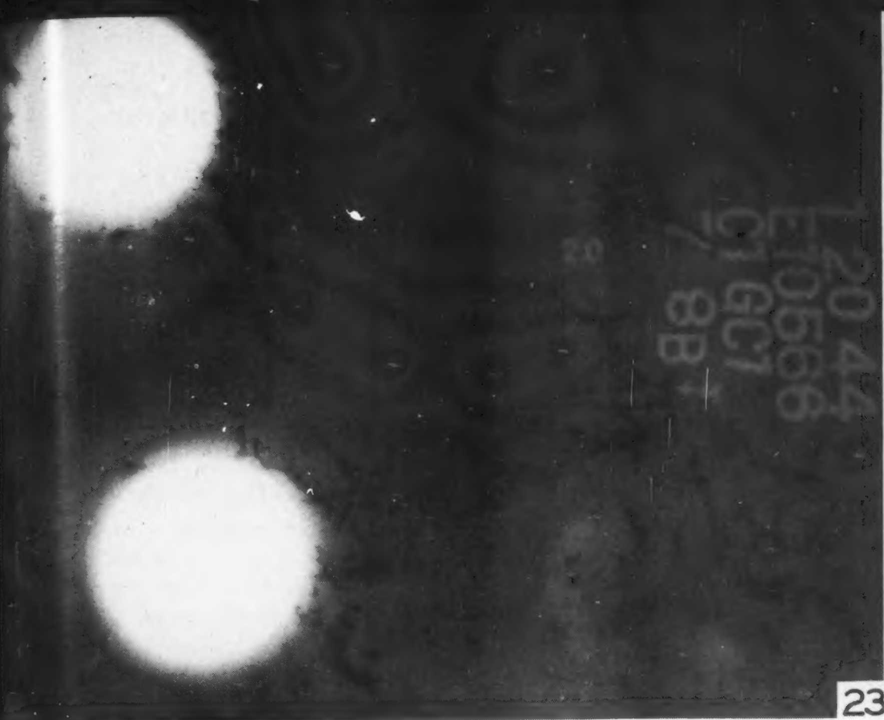


Fig. 21—Another attempt to remedy the shrinkage, shown in Fig. 19, has been made but despite the use of chills and cracking strip the defect can be seen in the machined flange. Fig. 22—Defect eliminated through revised method of employing chills and cracking strip.



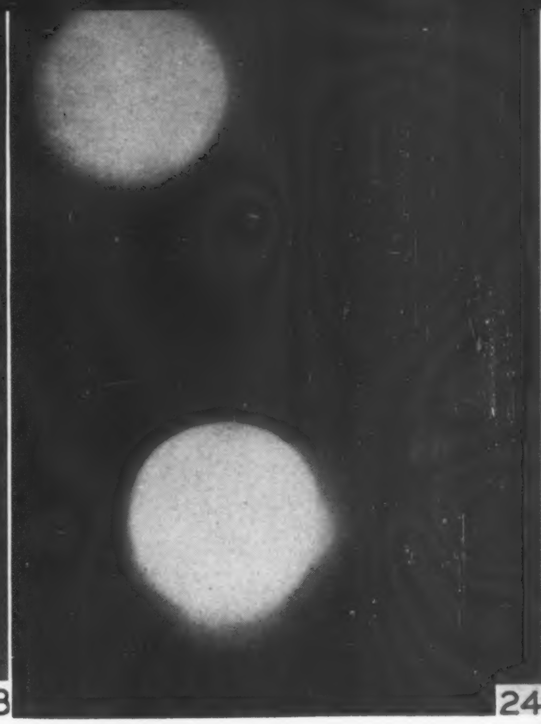


Fig. 23—The presence of shrinkage is detected by X-ray in a section containing two bosses. Fig. 24.—Defect was remedied by placing external chills on the bosses. (Reduced one-third for reproduction.)

sectioned, and the same interpretations of the action of the riser obtained. Sufficient work has not been done to elaborate further, but it is believed to be a promising procedure. It is hoped that the results obtained in sectioning may be obtained in less time and at a lesser cost by the use of X-ray. A typical example of the feeding action of a riser is shown in Fig. 25.

The X-ray has stressed the importance of cores and molds in regard to dirt and gas. Through the X-ray, the necessity of having properly baked cores as well as properly dried molds was learned. A casting weighing approximately 600 lb. and having a ring design with five blind risers and two open risers was poured. Its design did not lend itself to good ventilation and consequently gas troubles were encountered (Fig. 26).

More vents were taken off the mold and the results were not too encouraging. The blows seemed to have been dispersed but not eliminated (Fig. 27). By further investigation considerable variation in the baking of cores was found. Experiments

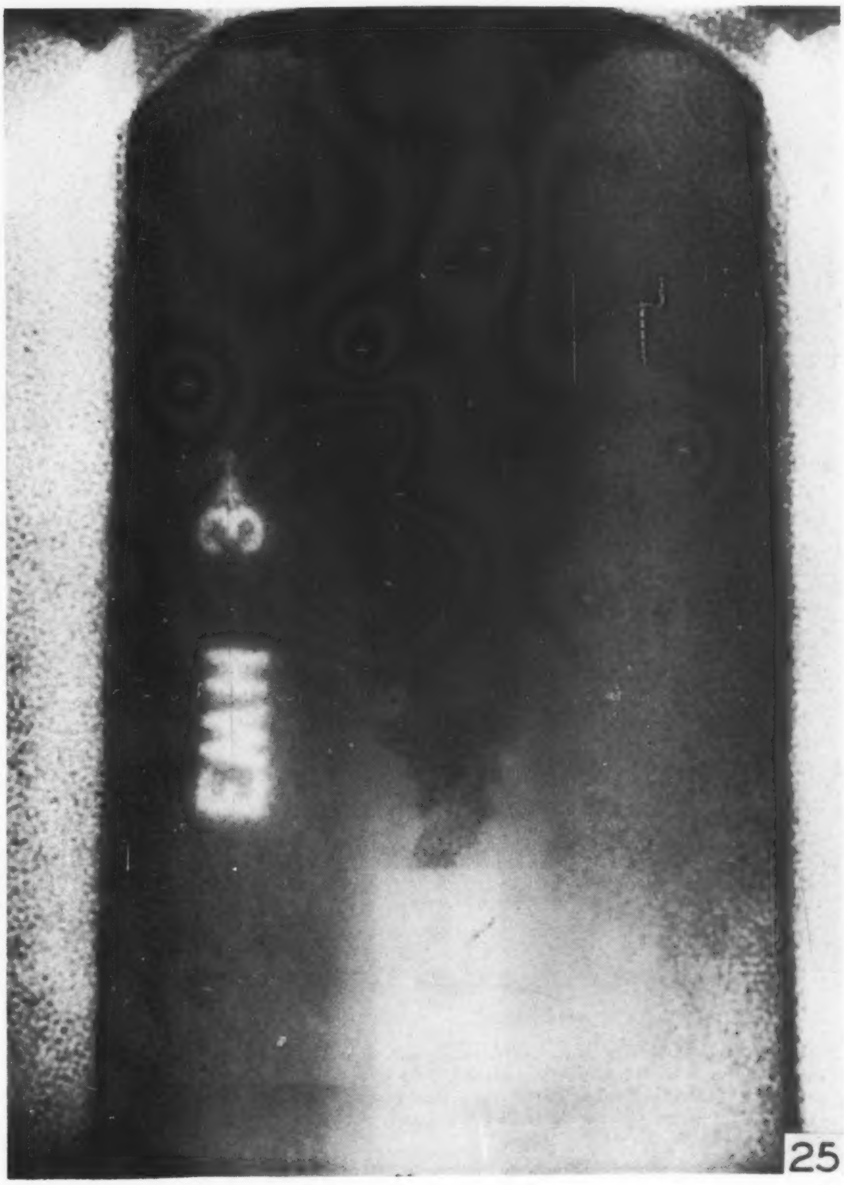


Fig. 25—Feeding action of a 6-in. riser as disclosed by X-ray. (Reduced one-fifth for reproduction.)

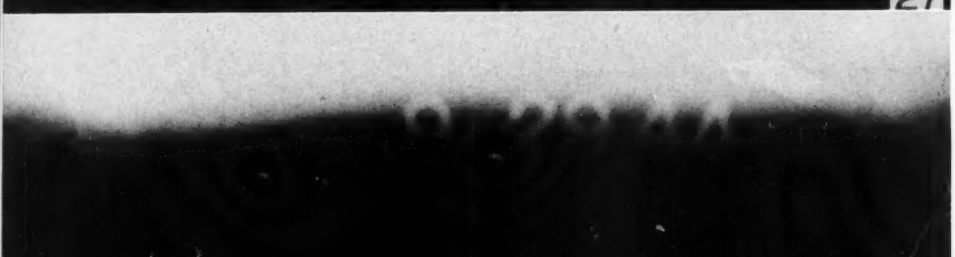


Fig. 26—Arrows in this X-ray are pointing out defects caused by gas in a ring design casting. Fig. 27—Better venting caused little change in the area as defects were only dispersed. Fig. 28—Elimination of gas in the casting was attributed to reduction of gas from the cores by thoroughly baking the cores. (Reduced one-third for reproduction.)

were made with more thorough baking of the cores, which reduced the gas content of the sand in the cores from approximately 35 cu. cm. of gas for a 3-gram sample to less than 20 cu. cm. for a 3-gram sample. The reduction of gas in the cores resulted in eliminating the gas condition in the casting (Fig. 28).

The speed of this test and the fact that the castings were not destroyed made it possible to improve the quality of the castings without increasing the cost, a factor that is always interesting to management.

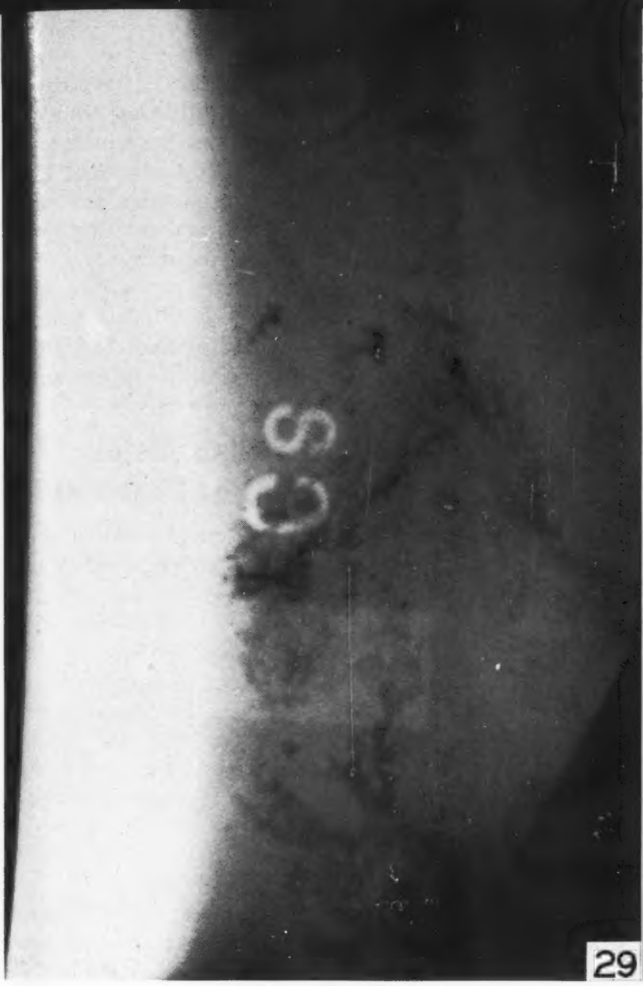
The second important use of the X-ray at this plant is in routine inspection. Once the proper technique and practice is developed, the job is still not finished due to the many variables which occur in the foundry.

We are all familiar with the variation that occurs from casting to casting. These variations are due, in some cases, to factors beyond our control, or due to the human element as well as slight changes in practices, materials, and actual mistakes. By spot checking the castings with X-ray, many of these slight variables are caught before the practice becomes serious enough to affect the quality of the casting. In non-destructive tests, such as the X-ray, both the foundry and the customer are given assurance that the practices are under control.

Development and Inspection

It is interesting to compare the present practices of development and inspection of castings with former practices. On a recent rush job, the casting was poured, heads and gates burned off, some rough chipping done and the casting X-rayed in an elapsed time of 3 hr. 50 min. The X-ray findings being satisfactory, the 450-lb. casting was put into immediate production.

Compare this with previous procedures. For much of the work the casting was given a visual inspection and then a physical test, followed with sectioning the highly stressed areas, or wherever defects appeared in the casting from the physical test. This procedure took several days at least, and sometimes as high as 10 days, before sufficient information was obtained to show whether the pattern should be resampled or whether it could be put into production. If the job called



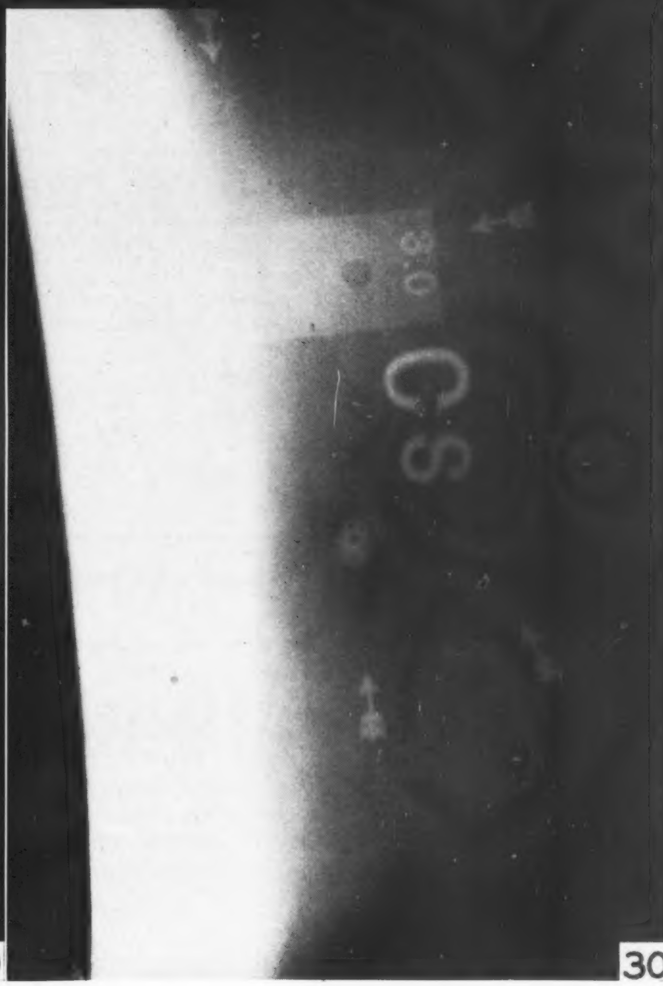


Fig. 29—An X-ray photograph revealing unacceptable shrinkage in a three inch section.
Fig. 30—Same section after shrinkage had been burned out and welded satisfactorily.
(Reduced one-third for reproduction.)

for re-sample, the entire process had to be repeated, resulting in further delay.

If it is believed that there is some chance that the casting will be satisfactory, it is the present practice to pour two samples in order to speed the process. One of these samples is for the inspection department and the other for the X-ray department. The X-ray casting is bu[illegible], rough chipped, blasted, and t[illegible] X-rayed.

Immediately after inspection of films the foundry has a complete picture of the condition, not only of the highly stressed areas but of the entire casting, and is ready to make the necessary changes in technique. This is generally accomplished in something like 48 hours after the casting is poured. The other casting, meanwhile, has been going through the regular procedure, being checked dimensionally by the inspection department.

Another noteworthy use of the X-ray in steel castings is the educational feature, the actual educating of the workmen themselves. In order to do this, meetings of the molders, finishers and coremakers are held. In these meetings are displayed X-rays showing areas of castings that are defective and the same areas after changes have been made correcting the defects. One would be surprised at the interest of each man. The enthusiasm shown by these men in seeing the actual results of their work pays dividends. Here are some comments made by a finisher at one of the meetings: "Now I can understand why my foreman insisted on those chill coils being placed exactly within a certain 6-in. area along that rail. I was angry because I thought that he was showing his authority. Now I see more of the why and wherefore. To get better results the company should show us more X-rays."

Employee Interest

Numerous comments of this type have been made. Their interests have been aroused and suggestions have been made freely by them, a number of which have been useful. Displaying X-rays to these men tends to create a better spirit between workmen and management. It is an immediate aid in the production of better castings.

X-ray pictures have been shown to the welders to illustrate the type of welds being made by them. It is felt that this has been of considerable help (from a quality viewpoint) in that it has assisted the men in improving the quality of their work.

X-ray has been an invaluable asset in the inspection of welded sections that are to have an expensive machined finish. It also is interesting to note that defective castings may be saved by burning out the defective material and repairing them by welding, using the X-ray to show whether or not the welds are acceptable. (See Figs. 29 and 30.)

X-ray also has played its part in proving to casting buyers that it is possible to make welds in steel castings, when necessary, that do not impair the stability of the product.

Experience has shown that cast-

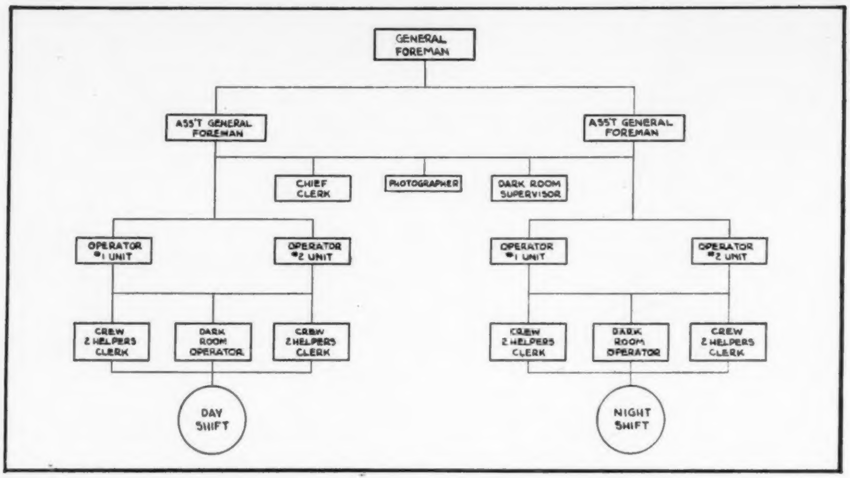


Fig. 31—A typical X-ray department organization chart.

ings need not be entirely free of defects to be serviceable. We have learned through fatigue, static, impact, and ballistic tests that certain defects inherent in castings are permissible in certain sections.

They do not impair the quality or performance of the casting in service. In order to use X-ray intelligently, each casting must be analyzed before being put into production to determine the most critical sections and those which will be subject to the highest stresses. These sections will then be required to pass higher standards of X-ray inspection. The Army and Navy, being cognizant of this fact, have set up different standards for certain areas in the same casting, and these standards may be used as a guide to industry. After all, the criterion of a good casting is performance.

In conclusion it should be mentioned that to get the most out of X-ray without undue expenditures, capable technicians must be employed, having the knowledge to enable them to X-ray a casting quickly and to bring out the defects present therein. Hand in hand with this talent goes proper interpretation of films so that the production men who are responsible for the practices and techniques are not misinformed and make the wrong move in the plant. A typical organization chart of an X-ray department is shown in Fig. 31.

At times it is advisable to combine the use of X-ray with sectioning, as mentioned before. The use of magnetic testing, physical testing, and of course, visual inspection, should not be overlooked.

Experience and knowledge of the use to which the casting is to be put enables a qualified person to know when a defect, as shown in the X-ray, is serious and when it is not. Thus the inspector knows whether the defect should be examined further by one of these other means of testing or whether the casting is satisfactory as it now stands.

Without a doubt X-ray is a tremendous asset to the foundryman in his aim of always improving his product. Also, if used properly it may be the means of considerable savings through the elimination of unsatisfactory castings, quicker inspection and, consequently, less time lost in getting a job into production.

Apprentice Winners to Be Announced July 18

ENTRIES in the 1945 National Apprentice Contests of A.F.A. were recently completed and the judging of entries scheduled for July 14. Winning entries will be announced at the Annual Business Meeting in Chicago, July 18.

The contests have been conducted in many plants throughout the country during the past six months, under supervision of the Apprentice Training Committee. According to Chairman C. W. Wade, Caterpillar Tractor Co., Peoria, Ill., apprentice entries have been received from the Northeastern Ohio, Wisconsin and Eastern Canada and Newfoundland Chapters, as well as a number of entries from apprentices in individual foundries.

In spite of wartime conditions, drastically reducing the number of apprentices in industry, the contests have continued to arouse considerable interest. They have been sponsored by A.F.A. annually since 1925.

This year's competition developed entries in patternmaking, steel molding, gray iron molding, and brass and bronze molding. In each class, a 1st prize of $30.00, 2nd prize of $20.00, and 3rd prize of $10.00 will be awarded the winning entries.

New Brazilian Metals Society Has First Meeting

THE first annual meeting of the newly organized Brazilian metals society, the Associacao Brasileira de Metals, was held at Sao Paulo and Volta Redonda, Brazil, on May 14-17, according to word from Dr. T. D. de Souza Santos, University of Sao Paulo, and national secretary for the group. The society was established last year as announced in the August issue of AMERICAN FOUNDRYMAN, and held several meetings during 1944.

Highlighting the 1945 annual meeting were visits to several industrial plants in the Sao Paulo area, including the largest steel plant in South America at Volta Redonda, which is scheduled soon to start operation. The plant includes coke ovens, blast furnaces and steel mills.

Col. Edmundo de Macedo Soares e Silva, superintendent of the Volta Redonda company, and president of the Brazilian society, opened the meeting with a talk on "A Policy of Metallurgy for Brazil." The annual scientific lecture was delivered by Prof. G. Wataghin, University of Sao Paulo, on "The Electronic Theory of Metals." Technical sessions were held throughout the week, 15 papers being presented.

The technical program proved to be well diversified in character with papers presented on blast furnace control, open-hearth deoxidation, hardenability of steels, heat treatment of cast iron, cupola operation, magnesium production, X-ray techniques and other phases of metallurgy. One of the technical papers was presented by Secretary de Souza Santos on "The Use of Sinter Iron Ore in Charcoal Blast Furnaces," who reports that 167 attended the meeting and that the total membership of the society now has passed the 250 mark.

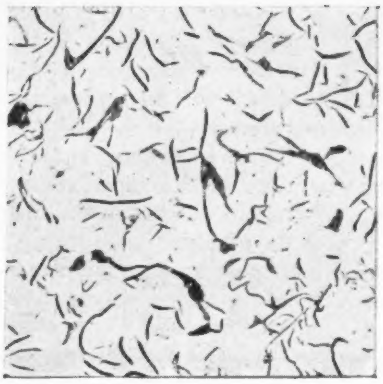


Fig. 1—Type A random distribution of graphite flakes in a matrix of pearlite. Graphite rating—5A. (Left) Unetched, X 100. (Right) Etched, X 750.

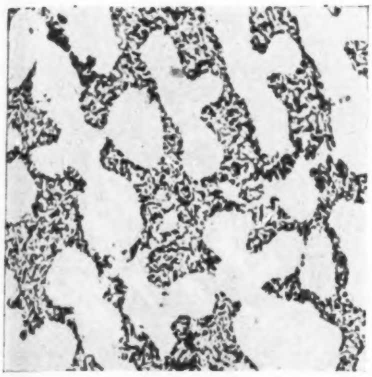
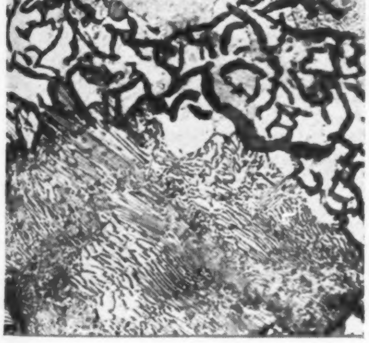


Fig. 2—Type D interdendritic (random orientation) graphite flakes. Etched structure shows tendency of massive ferrite (white) to be associated with this type of graphite distribution. Graphite rating—8D. (Above) Unetched, X 100. (Below) Etched, X 750.



Theories of Gray Cast Iron

INOCULATION

By H. W. Lownie, Jr., Metallurgical Engineer, Westinghouse Electric Corp., East Pittsburgh, Pa.

GRAY iron foundrymen during recent years have become quite interested in the process of inoculation. Many foundrymen responsible for the production of high quality cast iron have adopted an inoculation practice because they have found important product improvements to result.

In introducing a symposium on inoculation, it appears advisable to review in a general way some of the mechanics and theories of the process.

Rather than present throughout this discussion numerous references to various authorities, a general reference is made here to three publications[1-2-3] which discuss in more detail the present state of the theory and which present adequate bibliographies for the reader who wishes to study the subject further.

Inoculation may be defined as that process in which an addition is made to molten cast iron for the purpose of altering or modifying the microstructure of the iron and thereby improving the mechanical and physical properties to a degree not explainable on the basis of the change in composition.

To illustrate, iron analyzing, say, 3.20 per cent total carbon and 2.20 per cent silicon in the as-melted condition, may be inoculated with an addition of 0.20 per cent silicon. Some of the properties of the result-

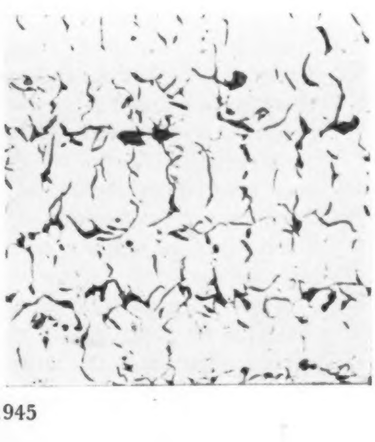


Fig. 3—Type E interdendritic (preferred orientation) graphite flakes in a matrix of pearlite. Graphite rating — 5E. (Left) Unetched, X 100. (Right) Etched, X 750.

Table 1
Classification of Typical Ladle Inoculants

Group 1		Group 2
Ca-Metal	Si-C	Cr-Si-Mn-Ti-Ca
Ca-Si	Si-Mn	Cr-Si-Mn-Zr
Ca-Si-Ti	Si-Mn-Zr	Mo-Si
Fe-Si	Si-Ti	Ni-Si
Graphite	Si-Zr	

ing 3.20 per cent total carbon, 2.40 per cent silicon iron will be considerably different from the properties of the original untreated iron, or from the properties of an iron melted directly (without inoculation) to the 3.20 per cent carbon, 2.40 per cent silicon composition.

The foregoing definition of inoculation is intended to exclude alloy additions made to the molten iron for the sole purpose of affecting the chemical composition of the melt (e. g., ferrochromium, ferromolybdenum, nickel, etc.), and to exclude materials added to the charge when those materials react with the metal before melting is completed.

These materials which are added to the iron to produce inoculation are called "inoculants," and the irons so treated are referred to as "inoculated" irons.

Inoculation Classification

One method of classification of inoculants is by placing them in two groups as follows:

Group 1—Inoculants which have the sole duty of producing inoculating effects (such as a changing of the graphite distribution and reduction of chill depth) to a degree considerably greater than can be explained on the basis of a change in composition. These inoculants usually contain one or more of the following elements: carbon, silicon, calcium, titanium, zirconium, and aluminum.

Group 2—Inoculants which, in addition to producing inoculating effects to a degree considerably greater than can be explained on the basis of a change in composition, also exert a supplementary effect which is explainable on the basis of a change in composition. In addition to one or more of the elements listed in Group 1, these inoculants also contain one or more additional elements which are not essential to the inoculating reaction but which do exert supplemental effects which are desirable in some applications.

The most common supplemental alloys used in this type of inoculant are chromium for the stabilization of carbide (pearlite), or nickel to promote carbide decomposition. Chromium and nickel are not considered as inoculating elements in themselves, as the effects of these elements are explainable on the basis of the change in chemical composition.

Typical ladle inoculants may be divided into these two groups as shown in Table 1.

The approximate analysis of each of these inoculants is given in one of the references[4] at the end of this paper. However, it should be added for the sake of completeness that, with the exception of metallic calcium and graphite, all of the inoculants shown in Table 1 probably also contain aluminum in amounts which are small but nevertheless may be quite significant.

Microconstituents Affected by Inoculation—Since the primary effect of an inoculant is to produce certain changes or alterations in the microstructure of the iron, it is necessary to define the microconstituents that are changed.

The most pronounced change resulting from inoculation is the change occurring in the distribution of the graphite flakes throughout the matrix or background metal. These graphite flakes may be large and coarse, fine and lacy, or even may be completely absent, depending upon the conditions of metal composition, cooling rate, and inoculation.

The A.F.A. and A.S.T.M. jointly have adopted a standard chart[5] for the classification of graphite flake size by number and graphite flake distribution patterns by type letter. This method of classification is used in this work.

First consideration will be given to illustrating the various microstructures involved. Subsequent paragraphs will illustrate when these particular structures are formed, and other articles in the inoculation symposium will discuss the effects of these changes in microstructure upon physical properties.

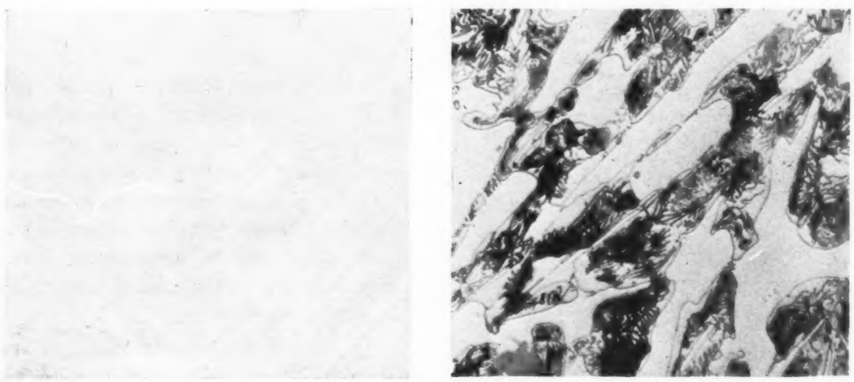


Fig. 4—White cast iron showing complete suppression of graphite flakes. White areas in etched structure are hard massive iron carbide (cementite). Graphite rating—none. (Left) Unetched, X 100. (Right) Etched, X 750.

Graphite Flake Distribution

Figure 1 illustrates large graphite flakes dispersed in a random manner through a matrix of pearlite. Such a random distribution of flakes is designated as Type A. The flake size is identified by a size number. Inoculation is performed for the purpose of promoting this Type A graphite.

Type D graphite is shown in Fig. 2. This fine and lacy graphite pattern is described as "interdendritic

• Mechanics and theories of the gray iron inoculation process are presented in this paper, serving as an introduction to the several papers comprising the "Symposium on Inoculation of Gray Cast Iron" which will appear in later issues.

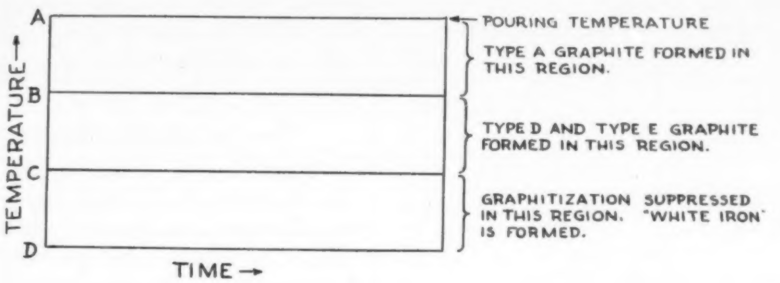


Fig. 5—Schematic representation of temperature regions of graphite formation.

segregation, random orientation." The continuous network of the fine graphite flakes tends to lower physical properties. In addition, free ferrite (as shown in the etched microstructure of Fig. 2) tends to be associated with this type of distribution and to lower the physical properties.

Inoculants are added to cast iron to attempt to eliminate this undesirable Type D graphite distribution and its associated ferrite masses.

Type E graphite (interdendritic segregation, preferred orientation, Fig. 3) also is considered as an undesirable form of graphite distribution. The statements regarding the undesirability of Type D graphite also refer to the Type E distribution.

"White Iron" Occurrence

Although Type D and Type E graphite generally are to be avoided, there are cases where the formation of any type of graphite is preferable to the occurrence of massive iron carbide ("white iron").

In such cases, although the inoculant may not be potent enough to produce the most desirable graphite distribution (Type A) by inoculation, it may, by the alloying effects of its constituent elements (e. g., silicon and nickel), result in the formation of one of the less desirable forms (Type D or Type E), which in turn may be preferable to the formation of massive iron carbide.

Figure 4 shows the case of an iron that has solidified completely "white," that is, there is no graphite present. The carbon in this iron which under some conditions would solidify as flake graphite has been retained in chemical combination with the iron and has formed the hard, white iron carbides that give "white iron" its name.

The A.S.T.M. - A.F.A. classification system also contains distribution ratings of Type B and Type C but, for the purposes of this discussion, these types may be considered as relatively unimportant.

Cooling Rate

Effect of Cooling Rate Upon Graphite Structure — The graphite structure of cast iron is determined primarily by its composition, cooling rate, and the degree of inoculation. Although the effect of chemical composition is of undeniable importance, the effect of cooling rate upon a given iron will be used to set up an arbitrary system for discussing the formation of flake graphite in cast iron.

This system then will be expanded to consider the effects of composition and inoculation. Although the system does make certain assumptions without confirmed metallurgical basis, it is believed that an attempt to make a graphical presentation will be helpful in discussing inoculation.

As an elemental hypothesis, consider that the temperature range from the pouring temperature down to "red heat" is divided into three regions, as shown in Fig. 5. In this schematic sketch the location of the dividing lines B and C is a subject of considerable experiment and debate over whether graphite can or cannot form directly from the melt or from austenite.

After an extensive review of the literature on the formation of graphite flakes, Epstein[1] stated: "It may be concluded that no clear-cut proof has been presented that an iron-graphite eutectic may form directly from the melt, neither is the contrary evidence which has been brought forth so positive as to preclude the possibility of the formation of such an eutectic."

With reference to our simplified diagram, this simply means that the solidification temperature (or temperature range) is not definitely located with respect to the lines (or regions) B and C. Although of considerable theoretical interest, the accurate determination of the location of these regions is not necessary to understand in a practical manner how inoculants work.

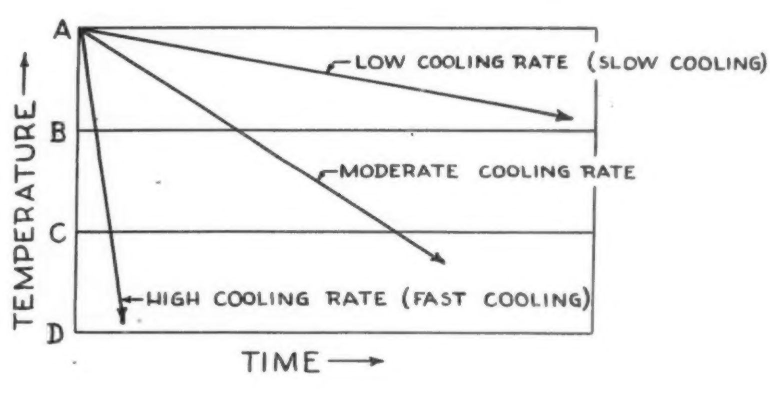
Graphitization Behavior

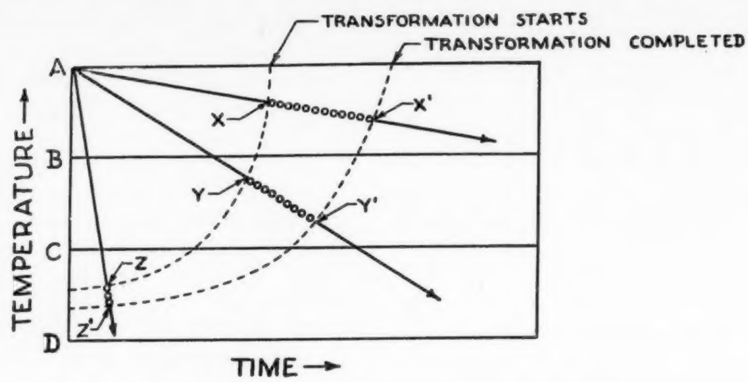
It is necessary to emphasize here that these schematic sketches are only approximate "behavior diagrams," and may not be interpreted too closely. The value of the diagrams lies in the fact that they do provide a simple manner of representing graphitization behavior.

The facts that the boundary lines A, B, C, and D are drawn at constant temperature and that the three regions are shown to be of equal temperature ranges should not be considered as significant.

Various cooling rates can be represented by lines of differing slope originating at the pouring temperature, as shown in Fig. 6. In ordinary

Fig. 6—Representation of cooling rate on schematic time-temperature diagram.





X, Y, Z—Points at which transformation starts with each of the indicated cooling rates.

X', Y', Z'—Points at which transformation stops with each of the indicated cooling rates.

Fig. 7—Representation of time required for graphitization or formation of white iron.

sand casting practice, low rates of cooling are obtained with thick casting sections, and high rates with thin castings. The use of chills also promotes high rates of cooling.

Physical transformations (such as the formation of graphite flakes) do not occur instantaneously. After the conditions for transformation are established, a time "lag" usually occurs before the transformation will commence, and then some finite period of time is required for reaction to be completed.

Such a transformation zone may be represented schematically on the diagram as shown in Fig. 7. An iron will not begin to form graphite flakes of the type indicated by a particular region until this minimum time is exceeded, and the graphitization that is going to occur will be complete when the cooling curve leaves this zone.

Time-Temperature Relation

Another concept is desirable. As the cooling rate becomes lower, the transformation temperature becomes higher and the time required for completion of the reaction becomes longer. This situation is represented in Fig. 7 by the increasing horizontal distance (time) as the cooling rate becomes lower.

The higher temperatures and longer transformation times at low cooling rates (slow cooling) cause the graphite flakes forming at low rates to become quite large. Rapid cooling and rapid formation of flakes result in flakes of a small size.

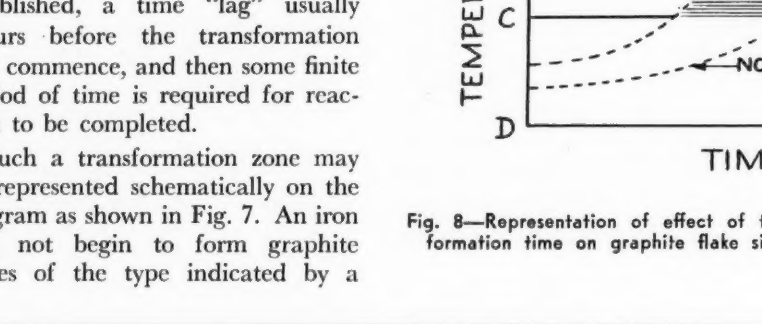
Fig. 8—Representation of effect of transformation time on graphite flake size.

Thus, Type A flakes (formed at low rates) usually are larger than Type D or Type E flakes (formed at higher rates). This situation is indicated in Fig. 8.

Bringing together the factors illustrated in Figs. 5 to 8, we now can draw a chart to illustrate the mechanics of graphite formation, as in Fig. 9. At Rate 1 (Fig. 9), graphite formation will begin and end in the Type A region.

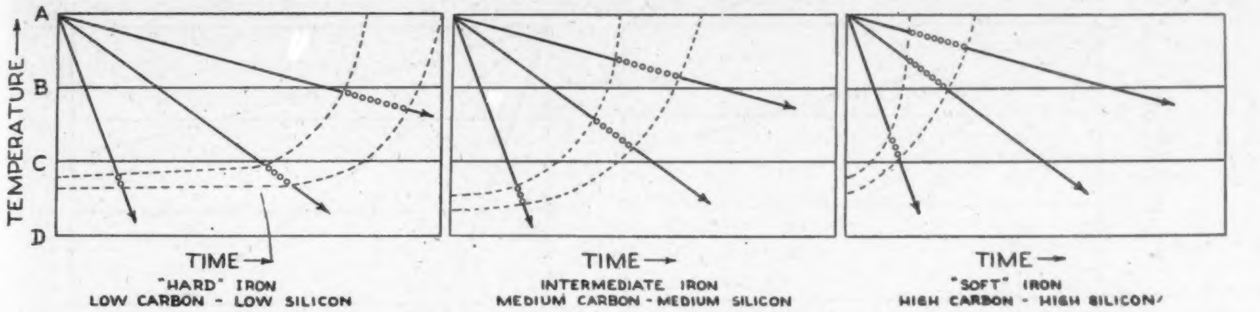
At a somewhat higher rate (2), graphite will form in the Type D and Type E region. At very high rates such as 4, graphite will be completely suppressed and white iron, free of graphite, will be formed.

Rates intermediate to these examples are also possible. For example, at Rate 3, some graphite will be formed in the Type D - Type E region, and the remainder of the car-



No.	*Rate*	*Product*
1	Low	Type A graphite.
2	Moderate	Type D or Type E graphite.
3	High	Type D or Type E graphite mixed with iron carbide (mottled iron).
4	Very high	No graphite (white iron).

Fig. 9—Solidification products formed at various cooling rates.



Forms Type D and Type E graphite on slow cooling; white iron with moderate or fast cooling. Very slow cooling required to form Type A graphite.

Forms Type A graphite with slow cooling, Type D or Type E with moderate cooling, and white iron with fast cooling.

Forms Type A graphite with slow and moderate cooling; Type D or Type E graphite at high rates. Requires very fast cooling to form white iron.

Fig. 10—Effect of composition upon graphite structure.

bon will form as white iron. It should be noted that transformations occurring in the white iron region result in the formation of "chill."

Irons which do not complete the formation of graphite in the Type A region (above boundary line B, Fig. 9) are referred to as undercooled or supercooled irons. It is the purpose of inoculation to prevent such undercooling and to cause all of the graphite to form in the Type A distribution.

Effect of Composition Upon Graphite Structure—Using the same type of diagram, the effect of changes in composition can be represented by a displacement of the "transformation zone." For a specific cooling rate there may exist an undercooled condition which produces Type D or Type E graphite flakes or massive cementite.

Low Carbon Iron

A "hard" iron (iron of low carbon content) will have a low transformation zone and will require very slow cooling to form Type A graphite. Even at moderate rates such an iron may form white iron. This situation is shown in Fig. 10.

A "soft" iron (high carbon, high silicon), on the other hand, will have a high transformation zone. Even moderate cooling rates will form Type A graphite flakes in such an iron; very high rates are required to form white iron ("chill").

One effect of the composition of the iron on the graphite structure, therefore, is to change the tendency of the iron to undercool. Low carbon, low silicon irons with a "low reaction zone" are quite prone to undercool, whereas high carbon, high silicon irons have less tendency to undercool.

Effect of Innoculation

Based on the hypothesis of the foregoing diagrams, the effect of inoculation may be stated quite simply—inoculation raises the "transformation zone." That is, inoculation may make an iron that would solidify (at a given cooling rate) as "white iron," or with Type D or Type E graphite, actually solidify with Type A graphite.

In this respect the inoculation effect is somewhat akin to "softening" the analysis of the iron, but instead of reducing tensile properties due to "softening" of the matrix, it actually improves properties due to the better distribution of the graphite flakes.

Stated in another way, inoculation permits the use of a stronger base iron in a given application with reduced tendencies to form chill (white iron) or undesirable graphite distribution patterns.

As low carbon, low silicon irons have considerable tendency to undercool, inoculation will be quite potent with such irons. However, high carbon, high silicon irons, which tend for the most part to solidify with Type A graphite anyway, benefit less from inoculation.

High carbon, high silicon irons are often poured into thin sections which introduce a high cooling rate which promotes undercooling. Therefore, inoculation is often as desirable for these irons as for the low carbon, low silicon types.

If a given inoculation treatment resulted in the formation of Type A graphite flakes exclusively at even the highest cooling rates, then such an iron could be called "completely inoculated." Present inoculation practices do not result in such "complete inoculation."

From the diagrams it can be seen that high cooling rates (fast cooling) promote undercooling. Therefore, with light sections the need for inoculation increases over the need in heavy castings (Fig. 11).

Inoculation Theories

Thus far in this discussion no attempt has been made to explain why inoculation has its peculiar effect upon the mode of formation of graphite in cast iron. Various investigators have proposed theories, but up to the present time no conclusive evidence has been obtained to establish any one theory.

The proposed theories overlap somewhat, but for the purpose of discussion may be designated as:

1. Graphite Nuclei Theory.
2. Degasification Theory.
3. Silicate Slime Theory.

According to the *graphite nuclei theory,* graphite particles in the melt act as nuclei to begin the graphitiza-

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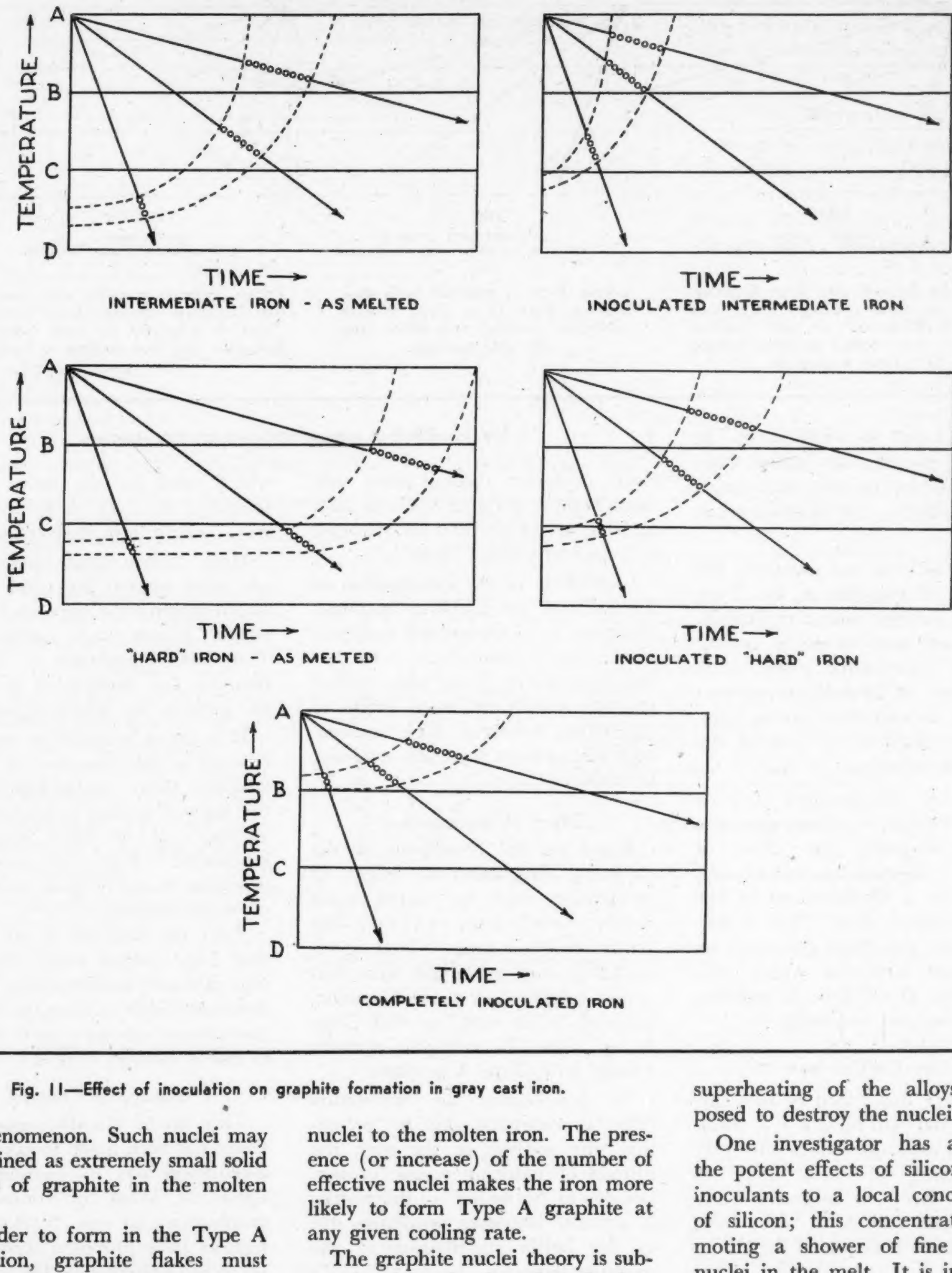

Fig. 11—Effect of inoculation on graphite formation in gray cast iron.

tion phenomenon. Such nuclei may be imagined as extremely small solid particles of graphite in the molten iron.

In order to form in the Type A distribution, graphite flakes must form on nuclei distributed through the melt. In the case of an iron which has solidified with Type D or Type E graphite (or as white iron), it has done so because it has passed through the temperature region of Type A graphite formation without forming any graphite flakes, and thus the graphite has formed in the lower temperature pattern.

Inoculation is considered here as the addition of effective graphite nuclei to the molten iron. The presence (or increase) of the number of effective nuclei makes the iron more likely to form Type A graphite at any given cooling rate.

The graphite nuclei theory is substantiated by the fact that the late addition of solid elemental carbon (granular graphite) to an iron normally solidifying with Type D or Type E graphite is known to change solidification to the Type A pattern.

Further evidence is the fact that certain alloys, which are efficient inoculants when added in the solid granular form, lose their inoculating ability when they are added as superheated molten alloys. Such superheating of the alloys is supposed to destroy the nuclei.

One investigator has attributed the potent effects of silicon-bearing inoculants to a local concentration of silicon; this concentration promoting a shower of fine graphite nuclei in the melt. It is interesting in this connection to note that most of the commercial inoculants contain appreciable amounts of silicon, a powerful "graphitizing alloy."

The tendency for superheated irons (irons heated considerably above the melting point) to form Type D and Type E graphite flakes in preference to Type A can be attributed (according to this theory) to the destruction of graphite nuclei

at high temperatures in the irons.

The *degasification theory* attempts to explain the mechanism of inoculation on the basis of reactions occurring between the inoculant and dissolved or chemically combined gases, such as oxygen, hydrogen, nitrogen, etc.

These "degasification" reactions may produce inoculation by (1) the elimination of "chill-forming" gases, and (2) the formation of inclusions in the melt which may act as effective nuclei.

It is known that inoculated irons show a "wearing off" effect. If molten iron is held for an appreciable time (of the order of 15 min.) between inoculation and pouring, the effect of inoculation gradually "wears off" and even may be eliminated.

Proponents of the degasification theory hold that this "wearing off" is due to reabsorption of the gases which were eliminated by the inoculation treatment.

It is a fact that most of the effective inoculants also are deoxidizers. On the other hand, other gases may be of more significance than oxygen.

The *silicate slime theory* provides for a submicroscopic "slime" or "pulp" of ferrous silicate inclusions which act as nuclei for the formation of coarse graphite. The theory is supported by the fact that a slag which removes silicon or ferrous oxide helps to promote the formation of fine graphite.

It has been pointed out that there is an analogy between this behavior and the popular belief that submicroscopic inclusions affect grain size in steel.

Nucleation Process

A certain similarity of these three theories is evident. The process of nucleation appears in each of them and, therefore, it may be supposed (for the present) that inoculation is at least partially the result of the addition of nuclei to the melt.

Numerous efforts have been made by various investigators to either prove or disprove each of the three theories but, as yet, no such effort has been wholly successful.

The microscopic or even submicroscopic size of the particles involved and the high temperatures at which the transformations occur impose major problems in the study of the solidification graphitization phenomena. The basic theory of inoculation is, therefore, still a debatable subject.

Conclusion

It is hoped that the foregoing discussion of inoculation will enable foundrymen to appreciate more readily the fundamental concepts behind the use of inoculants. The theory is not well-defined, as yet, but in its present state is sufficient to outline the graphitization transformations which occur when a cast iron is inoculated.

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Book Review

Heating, Ventilating, Air Conditioning Guide, 1944, 23rd edition, blue cloth bound, 9 x 6, 1216 pages. Published by the American Society of Heating and Ventilating Engineers, 51 Madison Ave., New York 10, N. Y. Price, $5.00.

The guide contains 48 chapters of technical data and information grouped under the general sub-divisions, principles; heating and cooling load calculations; combustion and consumption of fuels; steam and hot water heating; air heating, cooling and conditioning; automatic controls, instruments and motors; special applications and miscellaneous. A change in format has increased the amount of text per page and consequently much useful information has been added.

Among the features which add particularly to the value of the new edition are some of the following: The chapter on panel heating and radiant heating has been completely rewritten so that the first part deals with the influence of radiant heat upon the occupant and the latter part presents a new method for practical calculations of a panel heating system. An illustrative problem indicates simplifying assumptions which may be used to reduce the work required to design a satisfactory system.

The rewritten chapter on motors and motor controls includes typical performance curves and recommended control combinations for motors as well as typical motor specifications.

Under heat transmission of building materials, the use of separate columns for values of k and C will facilitate use of the tables of conductivities. Several materials have been added to the list for which heat transmission coefficients are given. A column of average annual minimum temperatures has been added to the table of climatic conditions in the chapter on heating load.

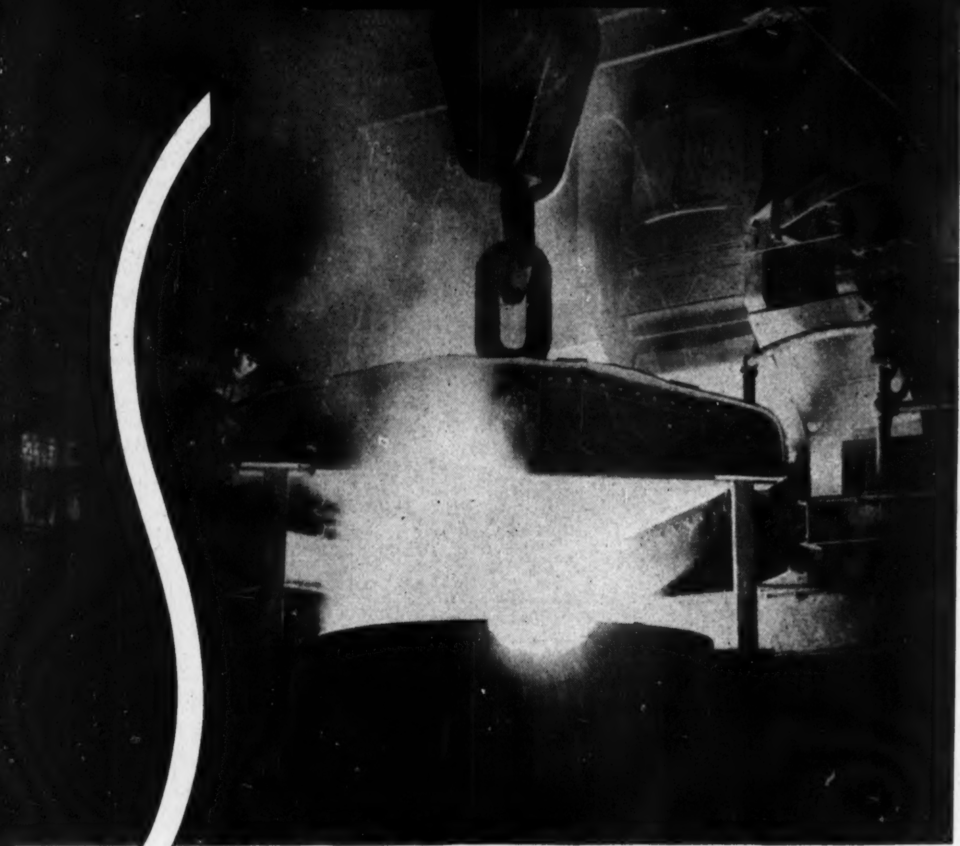
Selection of chimneys for gas appliances will be facilitated by the chimney selection chart added to the chapter on chimneys. In bringing the chapter on automatic fuel burning equipment up to date, reference was made to the recently adopted codes for rating stokers.

The chapter on heating boilers has been revised to include present accepted rating practice and includes clarified definitions of the various terms referring to heating load.

New data on high pressure steam systems have been added to the chapter which now includes steam heating systems and piping rearranged to facilitate reference to various systems.

Heat transmission data in the chapter on pipe insulation have been revised to agree with accepted values for present typical insulating materials.

Other changes in the guide includes: revised information on cooling tower practice in the chapter on spray equipment; a detailed presentation of fan laws and list of definitions of fans in the chapter on fans; and extensive changes in the chapter on industrial exhaust systems with addition of tables and data for practical design purpose.



STEEL FOR CASTINGS

. . . Methods of Production

A Report of the Steel Division Committee of A.F.A.

• Developments and trends in methods of producing steel for castings is reported to the members of A.F.A. Steel Division; some of the problems of current concern to steel founders—hardenability, grain size control, graphitization — are discussed briefly. An extensive bibliography of recent publications is appended.

DESPITE the exigencies and abstraction of a full-time schedule of war production, there seems to be steady progress in the methods of producing steel and in the quality of steel for castings. Problems imposed by the poor quality and heterogenious nature of available steel scrap have been fairly satisfactorily overcome.

It has been shown by Zang[12] how purchased alloy scrap may be used successfully up to 40 per cent of an electric furnace charge. By means of proper segregation and sampling methods, it is possible to use this amount of alloy scrap with a substantial saving in ferroalloy requirements and yet meet all current specifications as to properties.

In a prediction that electric furnace steel will compete directly with open-hearth steel in the postwar period, Sisco[25] concludes that basic electric steel can be made at a cost of $2.00 to $4.00 per ton above that for basic open-hearth steel, using a cold charge.

The quick immersion thermocouple[7] of the platinum/platinum-rhodium type, protected with a thin sheath of fused silica, is being used very successfully for measuring temperatures of molten steel. It requires from 10 to 20 seconds for a reading. The silica protection tube is good for a maximum of about six immersions, although, in practice, it is usually replaced after each reading.

One laboratory reports good accuracy in measuring temperature of molten steel by immersing a closed end silica tube in the bath and sighting down it with an optical pyrometer. This arrangement provides black body conditions free of smoke or fume, and it is claimed to be lower in cost than the thermocouple method.

Slag control, particularly for acid slags, is receiving considerable attention. Fitterer[33] reported that it is now possible to determine both the silica content and temperature of an acid open-hearth slag by means of a simple fluidity test. Furthermore, because the MnO is practically a constant, the FeO + CaO is then known, and if the CaO is a controlled quantity, the FeO content may be determined. He also proposed a new and interesting theory that oxidation of the bath by atmosphere is through direct exposure of the metal during the boil rather than through the slag as an intermediate.

Side-Blown Converters

In Great Britain, a much larger proportion of steel for castings is produced in side-blown converters than in the United States. Fassotte[27] has shown that, contrary to common belief, a high-silicon iron charge is not necessary when a side-blown converter is used. Whereas, in the bottom-blown converter, the product of carbon combustion is mainly CO, in the side-blown converter it is burned largely to CO_2. Thus, an important source of heat energy is available to the latter, which obviates the necessity of burning silicon if the initial temperature of the iron is sufficiently high.

A charge containing 3.2 per cent of carbon and 0.21 per cent of silicon was introduced to a converter at a temperature of 1385°C. (2525°F.) and successfully blown with a final temperature of 1590°C. (2895°F.). A rotary, pulverized-coal-fired furnace to act as a preheater and mixer is advocated for use between the cupola and the converter when low-silicon irons are used.

Thermit Method

The thermit method of producing steel for small castings has been completely successful in experiments carried out at the Naval Research Laboratory. Steels with very nornal properties were obtained. This method is considered primarily for emergency use where small castings are needed quickly in areas remote

from orthodox melting equipment.

Precision casting of many metals and alloys is presently undergoing intensive development. In preparing steel for these castings, indirect arc and high-frequency induction furnaces are preferred. An extensive line of melting units of these types, specially designed for precision casting, are being offered by various manufacturers. At least one small direct arc furnace is available.

Among the newer problems that are currently of concern to the steel founders are those of hardenability, grain size control, and graphitization. To a certain extent, these problems are interrelated and are problems of steelmaking technique.

Hardenability

Controlled hardenability for castings is increasingly in demand with the greater prevalence of quenching treatments. The problem is complex, because, with the variable section size both in single castings and in different castings from the same heat, no one hardenability level is ideal. Experience indicates that reliance on close chemical composition is not a sufficient control and that a direct hardenability test should be made on each heat.

This means segregation of heats for heat treatment. The ideal way, of course, would be to make a quick hardenability test before the heat is poured, and then make appropriate adjustments to the composition.

Grain Size

Controlled grain size as an adjunct to hardenability is important, but fine grain is specified for some cast parts which are to be carburized and quenched from the carburizing pot. The problem of obtaining fine grain is that of adding the proper excess of strong deoxidizer and, when aluminum is used, requires the same technique as is used to insure Type 3 inclusions for good ductility.

For certain uses, however, particularly for high-temperature service, coarse-grained steel is demanded. This has become a serious problem where the use of aluminum deoxidation is considered necessary to obtain the required soundness.

Graphitization

Of even greater current importance is the demand that steel castings for use in high temperature be made aluminum free to prevent graphitization. It has been found in weldments (both wrought and cast) used at high temperature, that graphitization starts in the heat-affected zone after prolonged exposure. This results in serious embrittlement. It has been shown that the rate of graphitization is increased when aluminum is used, unless it is used in such small amounts that it is all oxidized. Apparently no adequate answer to this problem has yet been found, but considerable experimental work is under way. A quick answer is not probable, however, because of the time required for tests.

COMMITTEE ON METHODS OF PRODUCING STEEL FOR CASTINGS

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INDUSTRIAL CODES GROUP

Upholds Yearly Progressive Record

By Chairman Jas. R. Allan,
International Harvester Co., Chicago, Ill.

THE membership of the Industrial Hygiene Codes Committee is intact notwithstanding many dislocations because of the war effort. This committee, still comprising a number of the original members, was organized about ten years ago, to develop data and recommended good practices for the promotion of better working environments in foundries and departments closely allied to the foundries, and to reduce accidents and occupational disease exposure.

To date this committee has promulgated a number of recommended practice codes. They are as follows: Code of Recommended Practices for Testing & Measuring Air Flow in Exhaust Systems; Code of Recommended Practices for Grinding, Polishing and Buffing Equipment Sanitation; Fundamentals of Design, Construction, Operation and Maintenance of Exhaust Systems; Code of Recommended Good Practices for Metal Cleaning Sanitation; Recommended Good Safety Practices for the Protection of Workers in Foundries; Code of Recommended Practices for the Protection of Life, Property and Production in the Foundry Industry During the War; and Code of Recommended Practices for Industrial Housekeeping and Sanitation.

Considerable of this code material has formed the basis for a great many of the state rules in Illinois and New York. All of the code material is well recognized throughout the United States and Canada, and the material is used quite extensively by various authorities, even where the rules have not been legally adopted.

The Code of Recommended Practices for the Protection of Life, Property and Production in the Foundry Industry During the War was written at the request of the Office of Civilian Defense, Washington, D. C., and carries that department's approval. This particular code, with very minor modifications, became the "protection code" for vital industries in such areas as the Chicago Metropolitan area, State of Wisconsin, and other locations.

The Code of Recommended Practices for Grinding, Polishing and Buffing Equipment Sanitation has become an American Standard under American Standards Association procedure.

The Code of Recommended Good Practices for Metal Cleaning Sanitation is in the process of becoming an American Standard.

Codes Will Be Developed

When conditions become nearer normal, and the committee members have some time to devote to committee activities again, more codes will be developed. At the present time we are experiencing difficulty in obtaining enough time to make some minor revisions in some of the codes that will have to be reprinted because the supply is exhausted.

The cooperation of industrial concerns has been splendid in helping the committee to develop engineering data in connection with a number of the code rules and formulae. It is most unfortunate that we do not have more research facilities to investigate and prove out fundamental facts, information on which is so sorely needed by engineers and technicians in connection with exhaust system engineering. We are hopeful that after the war an engineering department of some university will be come sufficiently interested to inaugurate and carry on a much needed research program whereby considerable scientific data will be developed because many of our design formulae in use today have been arrived at only through long experience by the trial and error method.

Many of the committee members, or those closely allied with them, have been put on important committees of national organizations, such as the National Fire Protection Association, in an attempt to bring a little more of the viewpoint of the industries that have to pay the bills, into the various committee reports and recommendations.

We believe that industry must be more active in the future in national organizations and governmental affairs dealing with industry and manufacturing problems that have a direct bearing on costs of construction and operation, so that any recommended rules may be clear, understandable and reasonable to accomplish the purpose intended and eliminate the delegation of authority.

"PHOTO POSITION FINDING"

A Time Saving, Money Saving Method of Communication

By A. C. Kalk, Continental Motors Corp., Muskegon, Mich.

• *A method for accurate description and transmission of casting discrepancy information has been developed by the author and is described in the paper. Working photographs illustrate the method.*

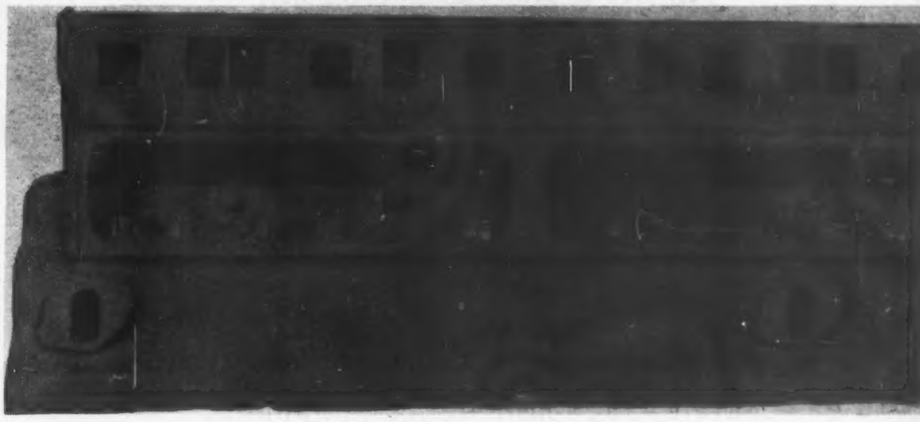


Fig. 1—Cylinder block casting.

IN THE past 25 years, foundry methods for fabricating castings have been improved considerably through science and the use of laboratories, to the extent that today foundries are able to produce quality castings by means of mechanical devices and, in some cases, without the experience of an old-time molder.

There is one problem with which all foundries have been confronted. In the author's mind, it is the most important of all—namely, close contact between a foundry and its customer on production problems. Any solution of the problem involves the finding of a method of communication between the purchaser and the producer of castings whereby the producer may be informed immediately and intelligibly regarding foundry discrepancies or imperfect castings.

By such a means of communication, the producer should be thoroughly informed, by letter, wire, or telephone, of any discrepancy that may occur on castings at the machine shop, when the difficulty results in the castings being rejectable to the producing foundry, so that the discrepancy can be corrected quickly before more imperfect castings are made.

The author has spent several years in the foundry business, and is well aware of the fact that there is no profit in rejected castings.

Prior to the outbreak of the war, users of castings made it a practice to purchase castings from foundries nearest to them, whenever possible. Today it has been necessary to procure castings sometimes at a distance of several hundred miles.

This presents the importance of notifying foundries as soon as possible regarding casting troubles, so as to eliminate the loss of several thousand parts that might be in transit and castings awaiting shipment at foundry to purchaser.

Informing the Foundry

An Example—Let us take an example of this condition. Purchaser *A* is procuring castings from Foundry *B* that is located 800 miles away. Purchaser *A* has an inventory of 1000 pieces. Foundry *B* has three shipments in transit which amount to a total of 1500 pieces. Foundry *B* has 100 castings awaiting shipment. Foundry *B* has a capacity of casting 500 pieces per day.

Assume that Purchaser *A* finds several castings that are rejectable from his inventory of 1000 pieces, due to imperfect castings furnished by Foundry *B*. It would be very costly to Foundry *B* if production were not stopped and necessary corrections made to overcome the difficulty immediately.

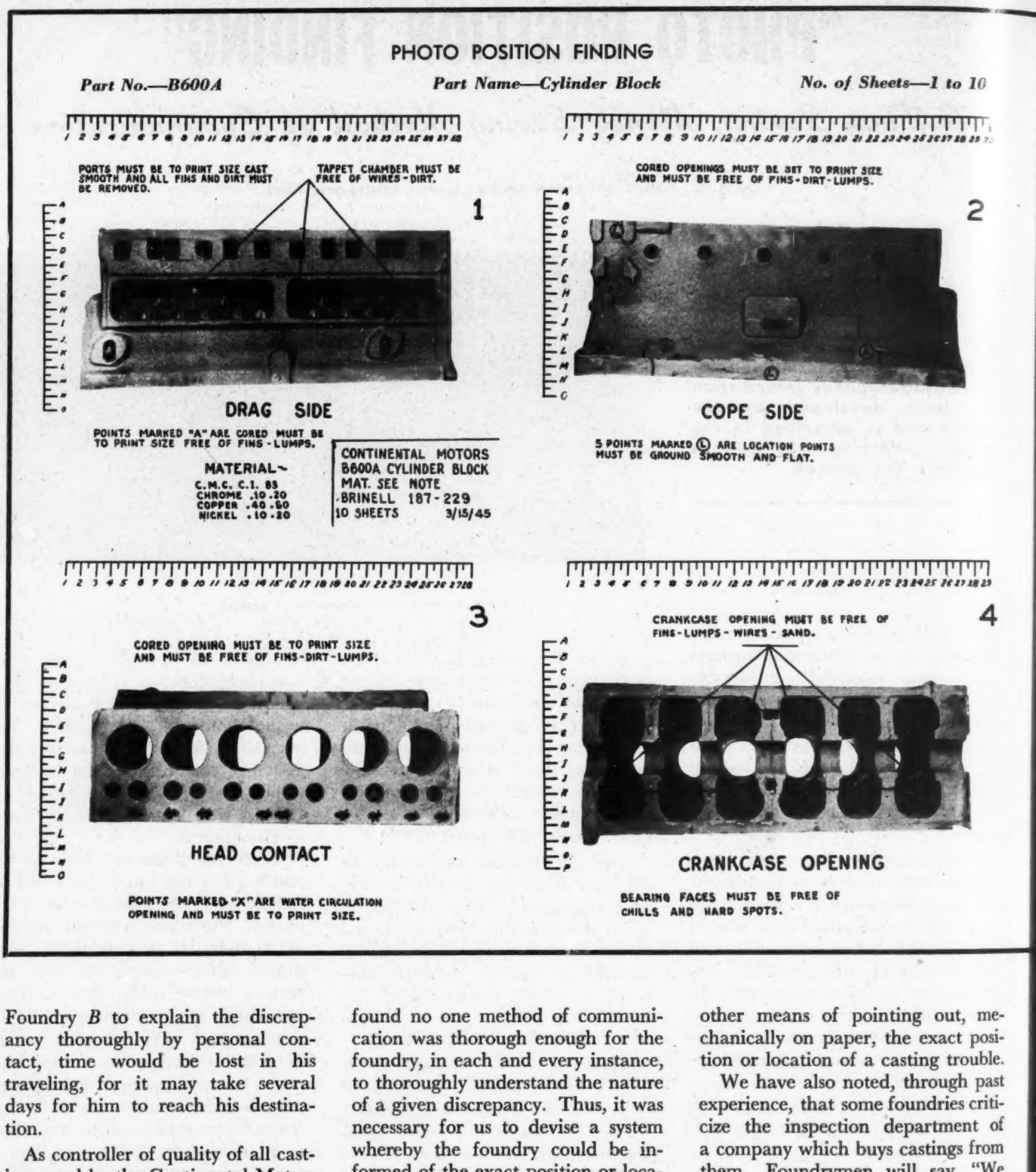
On the other hand, Purchaser *A* would suffer if production was stopped by Foundry *B*, because the assembly line using these castings could not continue to operate if castings were not forthcoming daily to Purchaser *A*.

There are a number of ways by which a foundry can be informed of difficulties encountered by the purchaser. Purchaser *A* could explain to Foundry *B* by telephone, telegraph, letter, marked drawing, returning casting, or by sending a representative to the foundry.

With the exception of the latter, the other means of communication could be misunderstood, and serious complications could enter the problem which might result in the rejections to Foundry *B* being of such a large percentage that any profit made in the past on the particular casting would be lost.

This probably would cause Foundry *B* to withdraw the pattern from production and perhaps return it to Purchaser *A*. If this were done, Purchaser *A* would likewise suffer, due to curtailment of production on a unit using the casting and to the time involved in finding a satisfactory new casting source.

If a representative were sent to



Foundry *B* to explain the discrepancy thoroughly by personal contact, time would be lost in his traveling, for it may take several days for him to reach his destination.

As controller of quality of all castings used by the Continental Motors Automotive Plant, Muskegon, Mich., the author is well acquainted with numerous examples of controversies between casting buyers and producing foundries. We, at the author's company, for a number of years have tried our best to advise foundries furnishing castings to us regarding the nature of a particular casting discrepancy as soon as it would present itself, by various methods.

Through years of experience we found no one method of communication was thorough enough for the foundry, in each and every instance, to thoroughly understand the nature of a given discrepancy. Thus, it was necessary for us to devise a system whereby the foundry could be informed of the exact position or location of trouble occurring in castings.

This, of course, can be done by marking blue prints, making sketches, or actually taking photographs of a defective part. However, this material must be presented in some way to the foundry, and time is involved.

It is no disgrace for a person not to be able to read a blueprint, and yet, without photographing or making a sketch of the part, there is no other means of pointing out, mechanically on paper, the exact position or location of a casting trouble.

We have also noted, through past experience, that some foundries criticize the inspection department of a company which buys castings from them. Foundrymen will say, "We had no knowledge that this point was a point of location or that the intake area of that manifold had to be free of fins and dirt."

This misunderstanding is costly, and by no means conducive to a happy relation between the parties involved. To remedy this situation, we have conceived an idea that covers all inspection requirements on castings in such a manner that there is no reason for foundries to

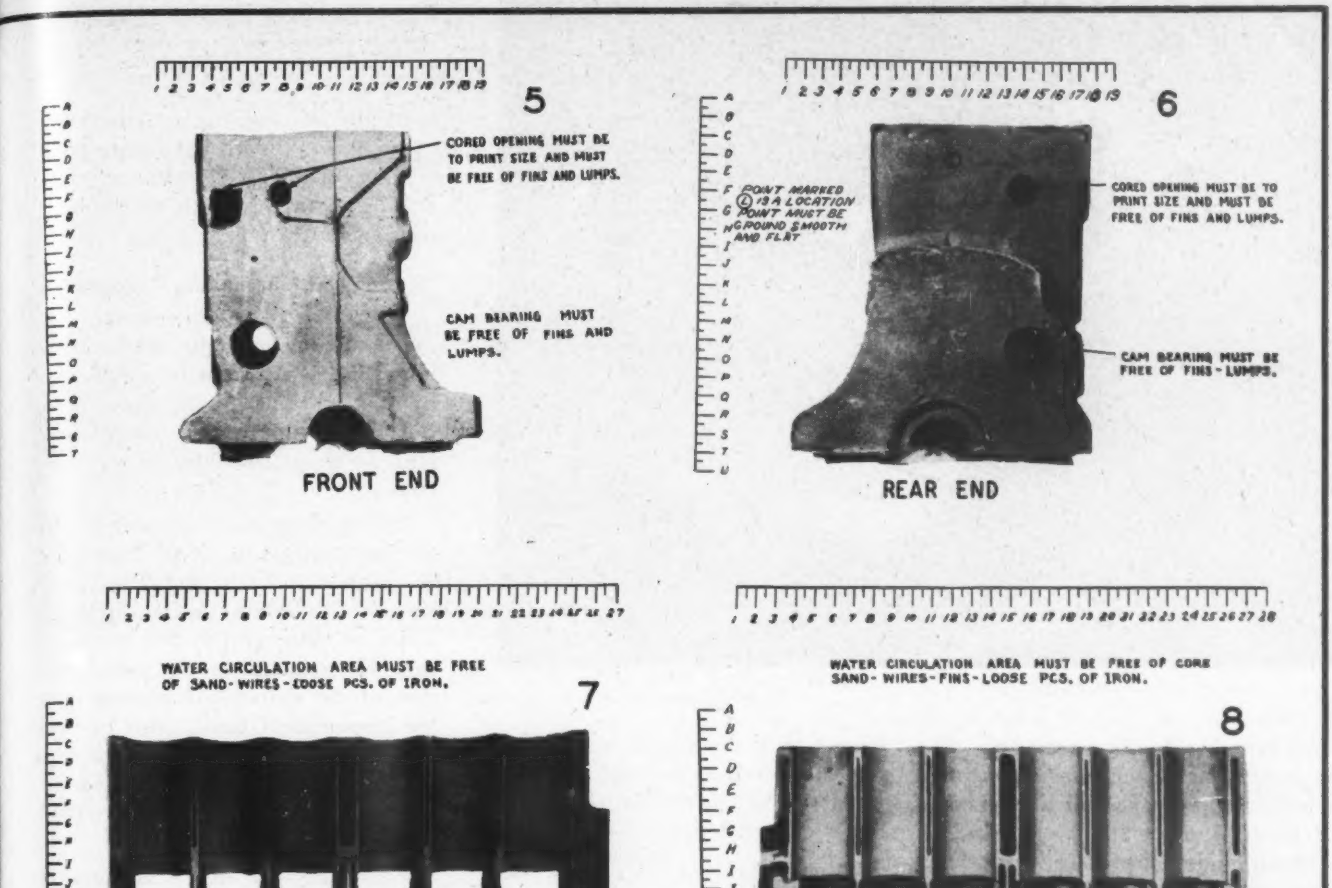


Fig. 2—Complete series of photographs on this and opposite page showing all views of cylinder block with inspection requirements noted on each view together with important points of inspection.

be without necessary knowledge of what is required for the production of a particular casting.

In conjunction with this idea, we are able to pass on information to foundries, accurately and understandingly, and to point out to any layman the exact location of a discrepancy. We term this method "Photo Position Finding."

We feel so much confidence in "photo position finding" that we believe it will be accepted by foundries and buyers of castings, because of its universal understandability.

To thoroughly explain "photo position finding" procedure, we will use a cast iron cylinder block, as

Fig. 3—Draftsman lettering necessary inspection requirements on one view of the cylinder block casting.

shown in Fig. 1, as an example. It is a complicated casting and one which might be classed as difficult to produce, especially by a foundry without wide experience with that type of casting. The first step is to photograph the casting from top, bottom and its various sides.

To thoroughly show all views of the cylinder block, we have photographed the six sides of this block. In addition, we have cut sections of jacket and cylinder bore areas, and of the intake and exhaust port valve openings. These views are shown in Fig. 2.

When the photographs are available, the necessary information concerning inspection requirements for the various parts of the casting, as shown on a given view, are lettered on each of the views. Fig. 3 shows a draftsman lettering one view.

For purposes of locating exactly on a casting a given defect or difficulty, we have developed standard positioning lines which are affixed at the top and left side of the photograph, as shown in Fig. 2.

The horizontal line at the top of the photograph is the length of the image and is numbered 1, 2, etc., with half lines between each numeral. The vertical line to the left of the photograph is as long, or longer, than the maximum height of the image. Bisecting lines are lettered A, B, C, etc., with half lines between each letter.

When all views of casting have been photographed, position lines affixed and necessary inspection requirements lettered on them, the originals are photographed in groups of four. The photographer is instructed to furnish a given number of copies of the photographs.

Photographs are distributed to the inspector of the plant purchasing casting, to the department head making contact with foundry furnishing casting, and to the foundry making the casting.

"Photo Position Finding" Operation

This is how "photo position finding" operates. Assume that a blow hole, Fig. 4, is found in a sufficient number of castings to cause their rejection to the foundry and to present a serious difficulty to the purchaser.

Let us designate the purchaser as *A* and the foundry as *B*. Purchaser *A*'s inspector finds the defect and refers to his "photo position finding" series of photographs for the casting. He then locates the exact position of the defect and reports it to the department head, who in turn verifies the location, as shown in Fig. 5. Please note that the defect shown in Fig. 4 is located at position D-13 in Fig. 5.

Following the exact location of the defect by both the inspector and the department head, the latter relays the position of the defect and its nature to Foundry *B*, which also has a set of "photo position finding" photographs of the casting.

Transmitting the Information—Telephone, wire or letter may be

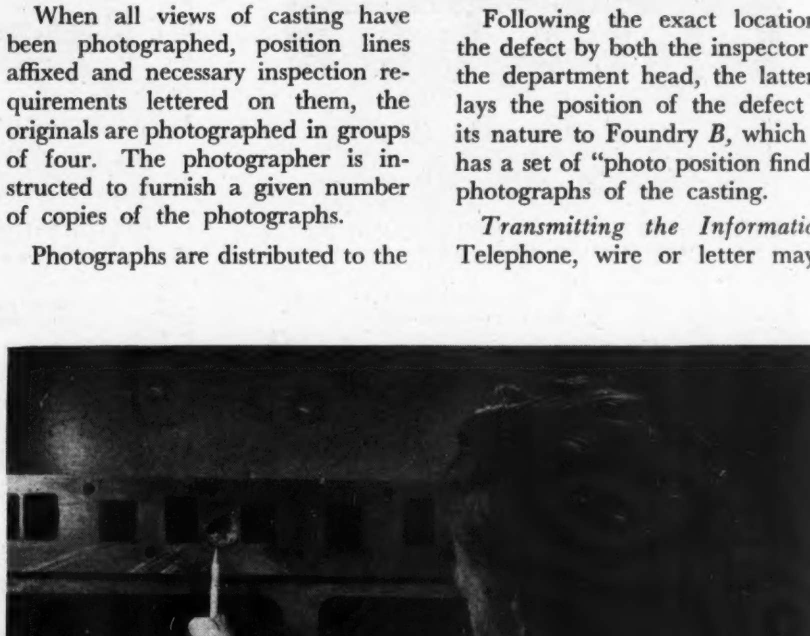


Fig. 4—Inspector pointing out large blow hole on manifold contact of cylinder block casting. The defect was not visible on the rough castings.

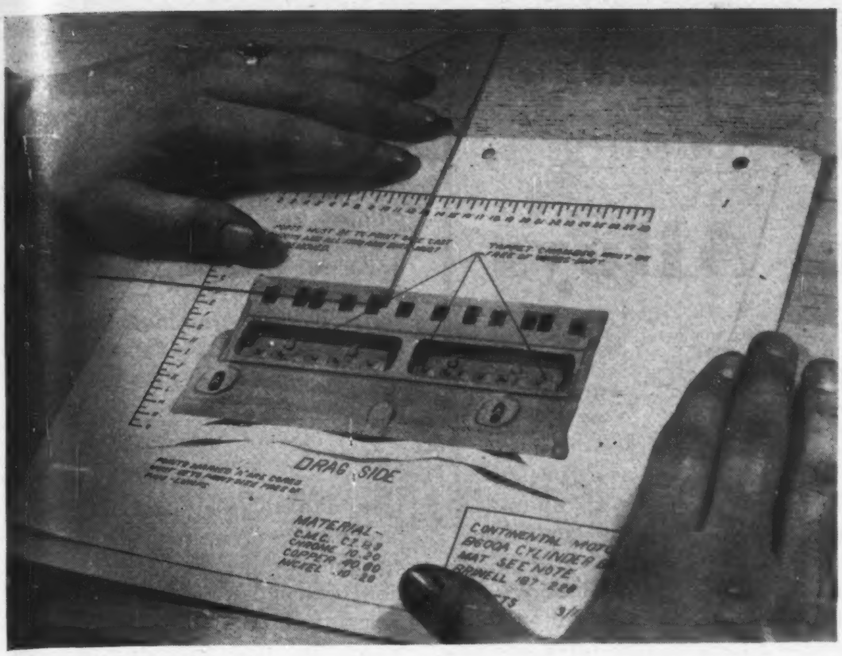


Fig. 5—Locating exact position of defect shown in Fig. 4 on photo position finding sheet before reporting location to the foundry. Position as noted is D-13.

used to transmit the position and nature of a defect. The facility chosen would depend on the seriousness of the condition.

The information transmitted to Foundry *B* should contain the following items to enable the foundry to locate exactly the difficulty involved on its "position" photographs:

1. Part number or casting symbol number.

2. Sheet number showing particular "position" photograph to be discussed.

3. Defect position (D-13, Fig. 5).

This information can be transmitted very easily to foundries by code by any of the facilities mentioned previously.

Foundry Receives Information—Foundry *B*, upon receipt of the information, locates the position of the difficulty on the proper photograph and relays this message to foundry department which this discrepancy may concern. Steps then can be taken to correct the foundry practice to eliminate the defect with minimum loss of production.

The method outlined above has been used by the company with which the author is affiliated with great success to save time and money on both its own part and that of producers from which it purchases castings. One of its outstanding advantages is that the method promotes good relations between buyer and seller—an important consideration in any business.

Advantages of Method

Photo position finding has a number of advantages in addition to those of exactly locating an error in a casting in a thoroughly understandable manner without mailing a drawing, submitting a casting or sending a representative to the producing foundry. These are:

1. The foundry or manufacturer of any particular item is acquainted, at all times, with the inspection requirements, because each view or photograph has its inspection requirement clearly printed on it and particular points are legibly marked. This eliminates controversies between the producer and purchaser of any commodity.

If the part purchased is sound and free of internal discrepancies and the producer abides by the inspection requirements on photo, there should not be any reason for misunderstanding what the purchaser expects as a commercial casting or commodity.

2. On parts that require chaplets, some foundries are today making notations on the backs of their photographs, detailing the position where particular size chaplets are to be used. The advantage of those notes is that when the patterns for the parts are put into production, errors, such as using chaplets of improper size or using proper size chaplets in wrong locations, will not occur.

3. Patterns that do not run regularly in the foundry are easily found in the pattern storage by first looking at photographs to gain knowledge of what pattern or casting looks like.

4. Photographs can be used by the foundry to refer to requested changes in the design of a casting. By referring to location of the desired change on the photograph or by placing a sheet of transparent paper over photograph and marking changes on it, the foundry can transmit its desires to the purchaser very easily.

If the latter method is used, in addition to marking the corrections, the locating lines at top and left of the photograph should be marked on the transparency. After the part number and photograph sheet number have been added, the transparency can be mailed to the purchaser.

Upon receipt of transparency, all purchaser need do is to use this photograph in conjunction with horizontal and perpendicular lines, marked on transparent sheet furnished by foundry, and the exact location of change requested by foundry can be found on photograph. This is very easily explained to the engineering department by the purchaser, and lost time is definitely eliminated.

Conclusion

There are an unlimited number of possibilities and uses of "photo position finding." The idea was conceived for castings and foundry purposes. However, this method of communication between two or more parties could be used on practically any part manufactured where close contact between purchaser and producer is necessary.

American Blower Corp. Awarded Fifth "E" Star

THE American Blower Corp., Detroit, Mich., was recently awarded the fifth Army-Navy "E" star for producing fluid drives for the war effort.

Principles of Die Casting

Magnesium Alloys

By C. E. Nelson and R. C. Cornell,
Metallurgical Dept., The Dow Chemical Co.,
Midland, Mich.

● *A discussion of magnesium alloy die casting production methods — alloys used — equipment and materials—operating practice—sizes and tolerances—machining and finishing. This paper was secured as part of the program for the 1945 "Year-'Round Foundry Congress" and is sponsored by the Aluminum and Magnesium Division of A.F.A.*

IN THE present discussion, the term "die casting" is used to designate pressure die casting as contrasted to gravity or permanent mold casting. The die casting of magnesium is a relatively new art in that it has only been practiced in the United States for about the past 13 years.

The evolution of the process as applied to magnesium alloys has necessarily led to the development of a lot of "know how" which goes to make up the art of casting. Many of these practices are plant or trade secrets which are not generally available, but must be acquired through actual experience. Since it is a fairly new field, equipment and methods have not been sufficiently publicized and standardized, with the result that many of the practices which are satisfactory under one set of operations are not entirely useful under a different set of conditions.

It is the purpose of the following discussion to present an up-to-date general picture of the methods by which magnesium die castings are made. Magnesium die castings can be readily made by methods not greatly different from other metals, notably, aluminum. However, it is important that attention be given to the working details described herein if the best results are to be obtained. Differences in physical characteristics of magnesium alloys require certain deviations from methods used in die casting aluminum, zinc, and other metals.

The discussion will be broken down into the following headings:

I. Alloys
II. Equipment and Materials
III. Operating Practice
IV. Sizes and Tolerances
V. Machining and Finishing

I. Alloys

A number of alloys have been used from time to time for magnesium die casting and have been described by Winston[1]. At the present time by far the largest proportion of die castings are being produced in A.S.T.M. alloy No. 13, which has the following nominal composition:

	Per Cent
Al	9.0
Mn	0.2
Zn	0.6
Mg	Remainder

This composition combines good casting characteristics with adequate mechanical properties and corrosion resistance. It conforms to Navy Aeronautical Specification M-369 and Army Air Corps Specification No. 11319. Typical mechanical properties obtained on standard A.S.T.M. die cast test bars are:

Tensile Strength, psi.	33,000
Yield Strength, psi.	21,000
Elongation in 2 in., per cent	3.0
Brinell Hardness	60.0
Izod Impact, ft. lb.	1.5

A second alloy used to a limited extent is A.S.T.M. No. 12, with the following nominal composition:

	Per Cent
Al	10.0
Mn	0.13
Si	0.5
Mg	Remainder

This alloy has been claimed to have somewhat higher fluidity, but shows lower corrosion resistance and somewhat lower elongation and impact properties. Typical properties on standard A.S.T.M. die cast test bars are as follows:

Tensile Strength, psi.	30,000
Yield Strength, psi.	22,000
Elongation in 2 in., per cent	1.0
Brinell Hardness	62
Izod Impact, ft. lb.	1.3

Recently, a grade of alloy No. 13 of controlled high purity and designated as A.S.T.M. No. 13x has been available for casting. This alloy has use where maximum corrosion re-

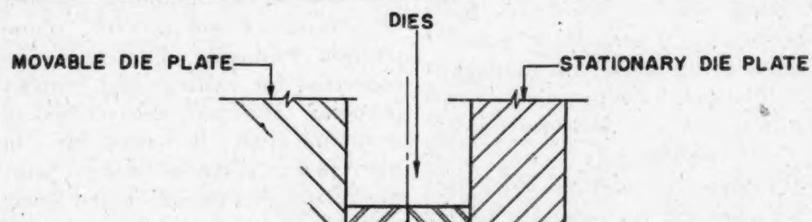


Fig. 1—Diagrammatic sketch of the cold chamber die casting machine.

sistance is required. Since die casting pot and casting temperatures usually are low, these pure alloys can be handled conventionally.

The addition of a very small amount, approximately 0.001 per cent, of beryllium has been made in some die casting plants in order to retard oxidation in the molten state.

II. Equipment and Materials

Die Casting Machines

High pressure, cold chamber type machines are most satisfactory, pressures as high as 50,000 psi. being used. Probably the average die casting pressure range for magnesium alloys would be around 4,000 to 15,000 psi. Low pressure machines, such as the gooseneck type operating at 400 to 600 psi., are not generally recommended. For general purposes, machines with die locking pressures of the order of 400 to 500 tons are desirable, due to the high injection pressures commonly used. Die clamping capacities would have to be considered in relation to the injection pressures in order that there will be sufficient locking pressure to keep the dies closed on the castings with the largest projected area which one would propose to make on the particular machine. It is very important that the machine have adequate strength and rigidity. The diagrammatic sketch of a typical cold chamber machine is shown in Fig. 1.

Figure 2 shows the diagrammatic sketch of the type melting pot in most common use for the die casting of magnesium alloys. The molten metal is protected against oxidation by means of SO_2 fumes generated in the double-walled dome shown in the sketch. The space between the walls contains a layer of sulphur, and the heat from the pot causes the sulphur to melt and sulphur vapor to issue through holes or slots surrounding the ladle opening in the sides of the cover. The sulphur vapors burn on contact with air, thus providing SO_2, which effectively inhibits active oxidation of the molten magnesium alloy at the operating temperatures between 1100° F. and 1300° F.

The pots are generally of 450-lb. magnesium capacity and are made of plain carbon cast steel. They are normally placed in brickwork settings and fired by either oil or gas. At the low temperatures of pot operation for magnesium die casting, such pots, even without any special protection, will often last as long as several years. However, they should be inspected very carefully at least once a month, and at such time any accumulated scale or oxide should be removed from the furnace settings.

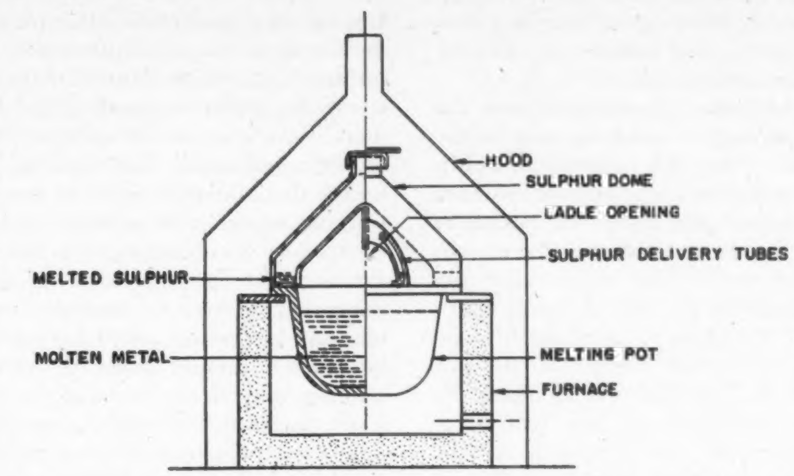


Fig. 2—Sketch of melting and protecting system for die casting magnesium alloys.

It is important that automatic temperature control be available for the die cast melting pots. Either galvanometric or potentiometric type controlling instruments are adequate, the former being cheaper and just as satisfactory for the purpose.

Thermocouples may be Chromel-Alumel or Iron-Constantan and should be protected in the pots by a steel pipe or sheath.

Fluxes and Agents

In the melting and refining of magnesium alloys for die casting, Nos. 220, 310, and 230 fluxes are used. The exact procedure for the handling of the molten metal will be described later. Protection agent No. 181 or 190 is also required during sludging and skimming operations.

Ladles, Skimmers, and Sludging Equipment

Die casting ladles are simply round-bottomed steel dippers with a handle about 18 in. long. The capacity is governed by the size of the casting to be made, and thus serves as a satisfactory metering device. A satisfactory skimmer can be made by welding a ¼-in. screen bottom to a 1½-in. length of 6-in. steel pipe. The handle should be long enough to suit the pot size. Sludge and flux pans may be of ordinary boiler plate construction made up to convenient sizes and shapes to permit easy removal of the frozen cake.

Die Design

Dies for casting magnesium alloys may be made from a number of tool steels on the market. For relatively short runs a carbon tool steel is satisfactory. For long die life a tool steel of the 5 per cent chromium-6 per cent tungsten type has been found satisfactory. The dies should be heat treated and drawn to a Brinell Hardness of about 400 to 450. The drawing temperature should be 1050 to 1175° F. so that the dies will not soften in use.

III. Operating Practice

Melting Practice

The sulphur dome melting method is used almost universally in this country for providing metal for die casting operation. It is considerably different from any of the other magnesium melting practices in that it uses No. 220 flux, which has the characteristic of being able to refine the metal, but does not have the property of giving surface protection. Since the die casting process requires the introduction of a ladle into the pot many times per minute, the use of a flux that gives surface protection might lead to the inclusion of flux in the metal because of the continued agitation. For this reason No. 220 flux has been definitely designed to do the refining and then settle to the bottom, so that it may be completely removed from the pot with the sludge. Surface protection in this pot is provided by an atmos-

phere of SO_2, which usually is generated by burning sulphur in a hollow dome that operates as a cover for the melting pot.

The ladle is introduced into the pot through a small opening in the cover. The SO_2 generated within the hollow dome is allowed to enter the space just above the metal in such a way as to blanket the molten metal surface and to inoculate the air entering through the ladle opening. The primary meltdown is done by dusting the surface of the pot with No. 220 flux and charging the solid metal into the pot, with careful attention and fluxing to prevent oxidation. When the batch is all molten, it is stirred thoroughly with the flux to agglomerate the oxide. It is next allowed to stand for about 10 min. to permit settling of the sludge and flux. The melt is then ready for sludging, which consists of removing the sludge with a skimmer perforated with 1/4-in. holes. The skimmer is preheated and put into the metal, scraping the bottom and sides of the pot.

Sludge Removal

When the skimmer is brought up with the metal and sludge, the molten metal runs through the perforations, leaving only the sludge, which is dumped into a preheated pan. After the sludge is removed from the bottom of the pot any dross or unsettled flux is skimmed from the surface and the metal should now appear clean and shiny. It is advisable to allow about 10 min. quiet standing before beginning to dip metal from the pot. The foregoing procedure is followed in starting up a new pot, but in normal operation it is preferable practice to keep the die casting pot relatively full of metal. This may be accomplished by adding fresh ingot at a rate sufficient to maintain a constant metal level, or, still better, do all of the melting in a separate premelting unit, using No. 230 flux and then transferring molten, refined metal directly to the casting pot by tilting or ladling from the premelter as convenient. If scrapped castings, butts, gates, etc., are charged into the premelter along with ingot, it is preferable to use No. 310 flux for the premelting. The melting of scrap is discussed later.

The usual pouring temperature range for die casting is from 1175 to 1250° F., so the oxidation tendency for the metal is relatively low. Due to the protective atmosphere the metal in the pot acquires a thin surface film, which must be parted when the ladle is introduced. If there is evidence of undue oxidation on the metal surface after ladling, it means that the sulphur dome is not working properly. Sometimes a very slight dusting of sulphur or other similar agent on the edge of the dome may be required to control oxidation. In no case would fresh flux be added to the pot unless the entire refining and sludge removal processes were to be repeated. In continuous operation, particularly if ingot is added directly to the pot, it may be necessary to reflux the pot every 4 to 8 hours. Ordinarily, from 1 to 3 per cent of No. 220 flux is used.

Unless absolutely unavoidable, it is not good practice to make alloy or alloy additions in the premelting or die casting pot.

Scrap Melting

The melting and refining of die casting scrap presents a special problem different from that for the bulk of magnesium scrap, in that a certain proportion of carbonaceous materials, lubricants, etc., is present on the scrap, so that melting and refining in No. 230 flux, as in ordinary practice, is not satisfactory. A reddish scum, or film, of the carbonaceous material seems to stay suspended throughout the metal. This behavior is eliminated through the melting of such scrap in open pots or crucibles, using No. 310 flux instead of the usual No. 230 flux. The No. 310 flux has the characteristics necessary to agglomerate the carbonaceous film and refine this material. Melting procedures are similar to the open pot operation for scrap recovery, except for the substitution of No. 310 flux.

Composition Control

Composition control usually is maintained by the following procedure:

1. Using certified alloy ingot.
2. "Blending in" premelted and refined die casting scrap of known composition which is periodically analyzed in the premelting unit or in the actual die casting pot.
3. Certification of the cast product on the basis of analyses of randomly selected castings from a given lot of actual castings.

Heat is applied to the die by electric strip heaters or a gas torch. Care must be taken that the heat supplied to the dies is as uniformly distributed as possible, so that warpage is prevented. In continuous operation, temperature of the die is maintained, and heat need be applied only after interruptions.

Die Temperatures

Die temperatures ordinarily run from 250 to 600° F., with 400° F. as a good average temperature. In regular operation, the heat is maintained in the dies by balancing the production rate. It is sometimes found that water cooling channels in the die are needed to limit the temperature to the desired degree. The optimum operating temperature for the individual die can be found only by actual operation. In general, however, castings requiring a large amount of metal will require water cooling of the die. Freedom from surface swirls and cold shuts is possible only when dies are maintained at the proper temperatures. The dies gradually become coated with a thin film of oxide, making other die coatings generally unnecessary. Too high die temperatures may cause excessive oxide film on the dies and rough surfaces on the castings.

When all conditions of the metal and dies are ready for casting, the pouring ladle is preheated on the rim of the pot before introducing it into the molten metal. After this preheat, the ladle may be held under the surface of the molten metal in the pot to bring it up to the metal temperature. This will prevent the metal from freezing to the ladle in the dipping operations. The ladle is filled by parting the protective film with the back of the ladle and dipping the ladle into the bath. The ladle is then lifted from the pot, transported to the machine, and the contents poured into the well, the injection being applied or the shot being made as soon as the last bit of metal from the ladle has been poured.

Operation Timing

Accurate timing of this operation and the shot speed is essential to constant production of good quality castings. Only experience on a given job will tell how soon the die should be opened after the shot. If, on repeated ladling, spots of burning occur on the surface of the molten

bath, they may be extinguished by a sprinkle of protecting agent No. 181 or No. 190.

The usual pouring temperature range for the metal is 1175 to 1250° F., depending upon the design of the casting being made. When it seems necessary to go above 1300° F. in order to obtain a good casting, the remedy should be sought in improved gating. In no instance should a pouring temperature of 1300° F. be exceeded, since sulphur dioxide will not provide sufficient protection for the metal at this temperature. The lowest casting temperature that will result in sound castings should always be sought.

Uniform Conditions

In starting to make castings after an interruption in production, it usually will be necessary to make quite a few castings before the die temperature and conditions become uniform. Until such conditions are stabilized, it is difficult to tell whether the particular casting setup is adequate for the job.

It is common practice to use lubrication on the injection plunger. Graphite type greases similar to those used in the cold chamber casting of other metals are recommended. The amount of lubricant used should be held to the minimum necessary to accomplish the desired result.

The gating method is undoubtedly the most difficult and, at the same time, most important phase of the operations upon which to make recommendations. It will be obvious that correct gating will depend on the size and type of the casting, as well as the equipment available.

Die design for magnesium generally is similar to that employed in aluminum die casting practice. The gates and vents will require special consideration. Large fillets, careful blending around section changes, and the rounding of sharp corners are advantageous. The following additional points may be of assistance as general considerations in the layout of the die:

(A.) It is of primary importance that the metal be placed in the die with a minimum of turbulence. In general, this can be most readily accomplished by bringing the metal in from the bottom. The effect of cores, thickness of section, and other factors in the casting shape which might lead to channeling or interference with the smooth flow of the metal must be considered and proper gating provided to minimize these effects. These points will have a direct bearing on the surface quality and soundness of the part.

(B.) Proper venting of the die cavity is also of paramount importance. Vents usually will be most effective near the top of the cavity, but may also be required at any other point where, due to the shape of the casting, entrapment of air might occur. The use of overflows or pockets which will permit some metal to flow out of the main die cavity at certain points which are otherwise difficult to fill is advantageous in many cases. Ordinarily, ejector pins and cores are so adjusted as to give as much additional venting as possible.

(C.) Gating should be so designed as to minimize the amount of hot metal flowing over any small area within the casting cavity, since this may lead to casting defects, as well as excessive accumulation of oxide on the die. Excessive oxide accumulation will lead to adhesion of the casting to the die cavity and may produce shrinks and cracks.

(D.) Much can be accomplished toward the improvement of soundness by the use of controlled injection speeds coupled with higher pressures. As a generality, most magnesium castings achieve the best surface quality through the use of injection speeds much higher than those normally used for aluminum.

Quality Control

Surface inspection of the casting occurs at three stages in most plants:

(1.) Hot inspection at the machine is made hourly on a representative number of castings. The purpose of this inspection, which is carried out by the regular inspection personnel, is to keep Plant Supervision, Casting Supervision, and the Chief Inspector constantly informed on the operation of each job. This procedure helps prevent a large quantity of scrap castings from being run before a particular defect is noticed.

(2.) Rough inspection of the castings takes place before the castings enter the clean-up department. Generally, this inspection is rather cursory and is carried out by the trim department for the purpose of avoiding the wasted labor of trimming obvious scrap.

(3.) It is generally preferred to carry out the final inspection after the castings have been given the chrome-pickle treatment. This final inspection is handled by the regular inspection department.

X-ray Inspection

Most new jobs are started out with the help of the x-ray. This has been found to be the most economical way of developing the proper venting, gating and casting procedure, even though the production control of the job may not require x-ray inspection.

If x-ray inspection of a job is to be carried out, it is done in accordance with the purchase specifications. In any event, it has been found good practice to radiograph a few castings after a part has been out of production for a time as a check on previously established practices.

The hazard of molten metal spitting out at the die parting line during the casting stroke is common to all types of die casting, and machines and working areas should be so located that occasional metal spitting cannot possibly contact personnel or inflammable material.

As has been previously discussed, it is very important that ingots, ladles, thermocouples, sludge pans, and other tools or utensils be fully preheated before coming into contact with molten metal or flux. Moisture or water coming into contact with molten magnesium can cause serious accidents.

Valves for fuel and air supply to the burners should be so arranged that they can be shut off at a safe distance from the melting and casting area in case of an emergency.

Fireproof Clothing

It is recommended that men working with molten magnesium wear fireproof clothing. The use of a face mask, fireproof flannel shirt, and leather chaps which cover the body from the waist down over the shoetops gives proper and effective protection. An effective fireproofing method for treating wool, corduroy, denim, and canvas consists of dipping the clothing (after it has been washed and centrifuged) in a 15 per cent solution of either diammonium phosphate or ammonium sulfamate. After saturating the clothing thor-

oughly in this solution, it is placed in a draining rack and the excess liquid allowed to drain back into the impregnating solution, which is kept in an earthenware crock. The clothing may then be dried directly or centrifuged for one minute and then put through the regular drying process. Clothing so treated will char, but will not flame when it comes into contact with molten magnesium or flux. The ammonium sufamate is less irritating to sensitive skin.

Methods of extinguishing magnesium fires have been dealt with in a number of publications and will not be considered here.

IV. Sizes and Tolerances

The limitation on maximum size of castings will be dependent, of course, on the equipment available. As has been stated previously, the size of a casting which may be made on a given piece of equipment is related to the projected area of that casting and the injection pressure required to produce a satisfactory product.

While wall thicknesses as low as 0.040 in. have been successfully cast, the more practical minimum is about 0.050 in. It has been suggested[1] that an approximate rule for wall thickness up to 0.130 in. has been 1/1000 of the surface area; thus, the minimum thickness for an area of 100 sq. in. would be 0.100 in. Numerous exceptions to this rule occur due to the casting design and the relations of the area in question to the gates.

The following tolerances generally apply to magnesium die castings:

	Inches
Tolerance per in. of dimension	±0.0015
Minimum tolerance within solid die	±0.003
Minimum tolerance across parting line or between solid die and movable die parts	±0.005

V. Machining and Finishing

Not too much consideration will be given to this subject, since die casters usually furnish the parts as cast with either the original surface or, perhaps, a chemical treatment for protection during storage.

The finishing of magnesium alloy die castings presents few problems, the methods used for other metals generally being applicable with little modification. Machining is easily accomplished, usually dry, but with an oil type coolant for high-speed operations if very accurate dimensions must be maintained. For extreme accuracy of parts, it may be desirable to stress relieve the die castings by heating for 2 to 4 hr. at about 400° F. before machining. Such a treatment also results in a stabilization of the alloy constituents such that a negligible amount of growth would take place if the casting is to be subjected to elevated temperature use. Unit growth for magnesium die castings is as follows:

	Inches
As die cast	0.00033
As cast and stabilized	0.00016

As has been previously stated, scrap from casting and machining operations should not be remelted for die casting directly, but instead should be refined in a separate pot, also described previously.

The chemical treatment usually applied by die casting producers is the chrome-pickle treatment, or perhaps, in some cases, the fluoride-dichromate treatment. Since details of these processes are covered elsewhere, no discusison will be given.

Reference

Winston, A. W., *"Magnesium Alloy Die Castings,"* PROCEEDINGS, A.S.T.M., vol. 39, pp. 284-296 (1939).

A.F.A. Cost Commitee Has Recommendations Available

FOUNDRY companies attention is called to the A.F.A. circular No. 43-45 entitled *"Recommendations to Buyers of Castings."* The Assocaition is prepared to supply this 8-page leaflet in quantities to companies for distributing to their customers. It covers recommended data required for accurately estimating casting costs. This material was first issued in 1931 and revised in 1942 by the A.F.A. Cost Committee. The committee personnel compiling these 1942 revisions is composed of the following: *Chairman,* C. A. Davis, Caterpillar Tractor Co., Peoria, Ill.; R. L. Lee, (Chairman, A.F.A. Cost Committee), Grede Foundries Inc., Milwaukee; E. W. Horlebein (Representing Non-Ferrous Founders' Society), Gibson & Kirk Co., Baltimore; C. S. Roberts, Dodge Steel Co., 6501 Tacony St., Philadelphia; Robert E. Belt (Representing Malleable Founders' Society), Malleable Founders' Society, Union Commerce Bldg., Cleveland; John L. Carter (Representing Gray Iron Founders' Society), Gray Iron Founders' Society, Cleveland; R. L. Collier (Representing Steel Founders' Society), Steel Founders' Society of America, Midland Bldg., Cleveland; and J. A. Wagner (Representing Malleable Division), Wagner Malleable Iron Co., Decatur, Ill.

The recommendations include discussion of design factors and quality, a form outlining information which should be supplied with requests for casting quotations, discusses information or data desired describing castings and the pattern equipment available, and data on quantity required and information concerning packing and marking.

Wisconsin Chapter Sponsors Lecture Course at Wis. U.

THE Wisconsin chapter, in an endeavor to bring the foundry industry much closer to student engineers, sponsored a 14-week lecture course at Wisconsin University, Madison, Wis. A leading foundryman, who is a specialist in his field, addressed the students each week. Students at these lectures were about to finish their courses and were looking around for the best industrial opportunities.

This course offered the students a chance to become acquainted with an industry that is dominated by craftsmen. The student engineer discovered that entering into the foundry industry would give him an opportunity to use his technical knowledge for scientific control of foundry practice.

Foundry engineers, metallurgists and executives that met with these students, discussed nearly every known phase of foundry practice. Subjects covered included gating and risering, binders and oils, melting practice in the cupola, molding and core sands, metallurgy and properties in steel, aluminum and magnesium, production of malleable iron, patterns, inspection, non-ferrous physical properties and many other foundry topics.

The entire program was arranged by the Wisconsin chapter's Board of Directors. The university urged the chapter to hold these meetings between foundrymen and students because it was felt that foundry training should be taught on a higher technical basis.

NEW ASSOCIATION MEMBERS

(May 16 to June 15, 1945)

• Twenty-three A.F.A. chapters reported a total of 98 new members for the period, May 16—June 15 . . . an excellent end-of-year record. Central Ohio with seven new members ranks first and Chicago second with six. The Erie group, which has not been officially proclaimed a chapter, is off to a good start with over twenty new members of which five are Company members.

Conversions—Personal to Company

Busch-Sulzer Bros.-Diesel Engine Co., St. Louis, Mo. (C. M. Brooks, Foundry Supt.) (St. Louis District Chapter).
Erie Malleable Iron Co., Erie, Pa. (P. H. Vincent, Gen. Mgr.).
Al Hallberg Pattern Co., Minneapolis, Minn. (Al Hallberg, President) (Twin City Chapter).
Pacific Graphite Works, Oakland, Calif. (James L. Blackie, Asst. Mgr.) (Northern California Chapter).

BIRMINGHAM CHAPTER

Dr. W. K. Allbritton Jr., Met., Gem Foundry, Birmingham.
***Kerchner-Marshall & Co., Birmingham (R. A. Donaldson, Repr.).**
Louis Seale, Molder, American Cast Iron Pipe Co., Birmingham.
***Tri-State Sand Co., Corinth, Miss. (Paul J. Wills, Mgr.).**

CANTON DISTRICT CHAPTER

Roy E. Jordan, Foundry—Production, The F. E. Myers & Bro. Co., Ashland, Ohio.

CENTRAL NEW YORK CHAPTER

Leon M. Bristol, Eastern Repr., E. J. Woodison Co., Syracuse, N. Y.
Stanford A. Mickel, Sales Engr., Shepard Niles Crane & Hoist Corp., Montour Falls, N. Y.

CENTRAL OHIO CHAPTER

James R. Cady, Asst. Supv., Battelle Memorial Institute, Columbus, Ohio.
Wm. E. Daugherty, Laclede, Christy Corp., Delaware, Ohio.
Francis Hartman, Foreman, The American Malleable Castings Co., Marion, Ohio.
John C. McCaughey, Ohio Steel Foundry Co., Springfield, Ohio.
Ernest H. Sonner, Molding Foreman, Ohio Steel Foundry Co., Springfield, Ohio.
Richard G. Storm, Met. Lab. Asst., Ohio Steel Foundry Co., Springfield, Ohio
Raymond Tillman, Foreman, The American Malleable Castings Co., Marion, Ohio

CHESAPEAKE CHAPTER

Ralph L. Fox, Lt. (j.g.) U.S.N.R., Met., Naval Research Laboratory, Washington, D. C.
W. I. Gladfelter, Chief Engr., Pangborn Corp., Hagerstown, Md.
Allen S. Kittrell, Owner, The Leach Pattern Shop, Baltimore, Md.

CHICAGO CHAPTER

Walter W. Jager, Sales, Central Pattern & Foundry Co., Chicago.
H. J. Martin, Miller and Co., Chicago.
Wayne Miller, Owner, Miller Model Motors & Miniature Machinery, Belle Plaine, Iowa.
W. K. Nelson, Gen. Mgr., Stewart-Nelson Co., Chicago.
Marshall T. Rydin, Sales Engr., Electrocast Steel Foundry Co., Cicero, Ill.
William J. Senger, Production Mgr., Electrocast Steel Foundry Co., Cicero, Ill.

CINCINNATI DISTRICT CHAPTER

***Allis-Chalmers Mfg. Co., Cincinnati.**
J. D. Catching, Service Engr., Master Tool Co., Inc., Middletown, Ohio.

DETROIT CHAPTER

Grant G. Bruckner, Foundry Supt., Ideal Furnace Co., Milan, Mich.
Robert E. Button, Supt., Ideal Furnace Co., Milan, Mich.
Clarence F. Finkler, Met., Westinghouse Electric Co., Centerline, Mich.

EASTERN CANADA & NEWFOUNDLAND CHAPTER

Roland Ferland, Foundry Foreman, Electric Steels Ltd., Cap de la Madeleine, Que.
Andrew Millar, Foundry Supt., Thompson Bros., Liverpool, N. S.
Donald Portree, C.E.R.A., Royal Canadian Navy, St. Johns, Newfoundland.

MICHIANA CHAPTER

***Fay Foundry & Machine Co., St. Joseph, Mich. Chas. E. Stoddard, Gen. Mgr.).**
Robert P. Sayers, Dist. Engr., Link-Belt Co., Chicago.
Ward Stuart, Sectional Steward Foundry Div. (Molder), Oliver Corp., South Bend, Ind.

NORTHEASTERN OHIO CHAPTER

Alexander Burns, Engr., Robins Conveyors, Inc., Cleveland.
Frank S. Jones, Development Engr., Black Drill Co., Cleveland.
George Mengele, Foreman, National Malleable & Steel Castings Co., Cleveland.
Edward I. Sadloski, Student, Fenn College, Cleveland.

NORTHERN CALIFORNIA CHAPTER

Walter C. Chedic, Co-Partner, Pacific Graphite Works, Oakland, Calif.
Clinton T. Harry, Pacific Graphite Works, Oakland, Calif.

PHILADELPHIA CHAPTER

Tom Holland Nelson, Consultant, Research Laboratory, Villanover, Pa.
Harry E. Rastatter, Service Engr., Master Tool Co., Inc., Philadelphia.

QUAD-CITY CHAPTER

Gustav Carl, Foundry Supt., Illini Foundry, Peoria, Ill.
M. Koener, Chief Inspector, Caterpillar Tractor Co., Peoria, Ill.
***Martin Machine & Foundry Co., Centerville, Iowa (W. Leo Martin, Mgr.).**
Joseph K. Patterson, Methods Engr., International Harvester Co., Rock Island, Ill.
E. Derry Williamson, Student, Iowa State College, Ames, Iowa.

SAGINAW VALLEY CHAPTER

Roland Kwaiser, Foreman, Saginaw Malleable Iron Div., Saginaw, Mich.

ST. LOUIS DISTRICT CHAPTER

Gene Conreaux, Sand Research, Key Co., East St. Louis, Ill.
Walter F. Gevers, Foundry Supt., St. Louis Malleable Casting Co., St. Louis, Mo.

SOUTHERN CALIFORNIA CHAPTER

***Aluminum Products, Los Angeles (Ralph Enriquez, Co-Owner).**
Chas. G. Gribble, Jr., Lt. U.S.N.R., Supt., Repair Base Foundry, San Diego, Calif.

TEXAS CHAPTER

Geo. L. Bolman, Partner, Star Foundry Co., Houston.
Harris T. Gregg, Dist. Mgr., Metal Goods Corp., Houston.
T. H. Robinson, Supt., Trinity Valley Iron & Steel Co., Inc., Fort Worth, Texas.
***Trinity Valley Iron & Steel Co., Inc., Fort Worth, Texas (C. W. Williamson, Vice-Pres.).**

TOLEDO CHAPTER

John Abraham, Supv. of Core Dept., Unitcast Corp., Toledo, Ohio.

TWIN-CITY CHAPTER

Albert Bealer, Shop Foreman, Midway Iron Works, St. Paul.
R. C. Hallberg, Supt., Al Hallberg Pattern Co., Minneapolis.

WESTERN MICHIGAN CHAPTER

***Enterprise Brass Works, Muskegon, Mich. (Wm. T. Holt, President).**
Albert Larsen, Enterprise Brass Works, Muskegon, Mich.
Milford McConnell, Foundry Foreman, Cadillac Malleable Iron Co., Cadillac, Mich.
Otto Ross, Core Room Foreman, Campbell Wyant & Cannon Foundry Co., Muskegon, Mich.

WESTERN NEW YORK CHAPTER

John A. Beane, Consulting Engr., Metal & Alloy Specialties Co., Buffalo, N. Y.

WISCONSIN CHAPTER

W. G. Ewart, Supt. of Quality, The Falk Corp., Milwaukee, Wis.
William E. Hughes, Nash-Kelvinator Corp., Kenosha, Wis.
Joseph J. Schmitt, Casting Inspector, The Falk Corp., Milwaukee, Wis.
Frank Tishacek, Finishing Foreman, Sivyer Steel Casting Co., Milwaukee, Wis.
L. V. Tuttle, Consulting Foundry Engr., Milwaukee, Wis.

OUTSIDE OF CHAPTER

Wm. J. Bartels, Asst. Treas., Erie Malleable Iron Co., Erie, Pa.
Joseph Bauer, Foreman, Erie Malleable Iron Co., Erie, Pa.
***Bucyrus-Erie Co., Erie, Pa. (Kenneth T. Guyer, Gen. Foreman).**
George W. Cassady, Owner, Erie Industrial Supply Co., Erie, Pa.
***Chicago Pneumatic Tool Co., Franklin, Pa. (L. F. Hoffman, Mgr.).**
Clyde E. Cooper, Foundry Supt., Keystone Brass Works, Erie, Pa.
Louis A. Dollivar, Time Study Engr., Standard Stoker Co., Erie, Pa.
***Erie Engine & Mfg. Co., Erie, Pa. (Howard Heath, Foundry Supt.).**
Edwin J. Hay, Foreman, Erie Malleable Iron Co., Erie, Pa.
Bailey D. Herrington, Service Tech., Hickman, Williams & Co., Erie, Pa.

*Company Member.

***Jyoti Ltd., Baroda, Baroda State, India (Nanu B. Amin, Mgr. & Engr.).**
***Keystone Brass Works, Erie, Pa. (M. H. Rowley, Vice-Pres.).**
Martin T. Lacey, Met., Erie Malleable Iron Co., Erie, Pa.
Library, Michigan College of Mining & Technology, Houghton, Mich.
Roy A. Locer, Chief Inspector, Erie Malleable Iron Co., Erie, Pa.
John R. Metcalf, Engr., Erie Malleable Iron Co., Erie, Pa.
Ray W. Miller, Met., Gilbert & Barker Mfg. Co., West Springfield, Mass.
W. J. Miller, Service Engr., Frederic B. Stevens, Inc., Erie, Pa.
F. L. Moore, President, Peerless Mineral Products Co., Conneaut, Ohio.
D. L. Ottaway, Asst. Secy., Erie Malleable Iron Co., Erie, Pa.
Henry F. Pfeffer, Pattern Foreman, Erie Malleable Iron Co., Erie, Pa.
Walter G. Quayle, Foundry Supt., Erie Malleable Iron Co., Erie, Pa.
O. F. Rehn, Exec. Vice-Pres., Pittsburgh Steel Foundry Corp., Glassport, Pa.
Floyd L. Shields, Jr., Chemist, Erie Malleable Iron Co., Erie, Pa.
***Skinner Engine Co., Erie, Pa. (W. K. Bonnell, Production Mgr.)**
Earl M. Strick, Finishing Supt., Erie Malleable Iron Co., Erie, Pa.
***United States Metal Products Co., Erie, Pa. (E. B. McElroy, Vice-Pres.).**
Frank Warner, Foreman, Griswold Mfg. Co., Erie, Pa.
Stanley A. Zubowski, Finishing Foreman, Erie Malleable Iron Co., Erie, Pa.

*Company Member.

Foundry Personalities

Carl E. Rowe, a Chicago chapter member for the past six years and for some years Secretary of the A.F.A. Committee on Job Evaluation and Time Study, has recently taken a position as Post War Engineer, Muskegon Piston Ring Co., Sparta, Mich.

Clyde Williams, Director of Battelle Memorial Institute, Columbus, Ohio, was recently presented the degree of Doctor of Science at the Case School of Applied Science, Cleveland, Ohio.

Dr. Williams presented at the 1923 A.F.A. convention the first paper on melting iron in an electric furnace.

Clyde Williams

Dr. H. Ries

Dr. Heinrich Ries, professor emeritus of geology, Cornell University, Ithaca, N. Y., received the honorary doctor of science degree at Alfred University, Alfred, N. Y.. recently.

Dr. Ries is Technical Director, A.F.A. Sand Research Project, and a well known authority on sand. He has served on numerous sand committees during his association with A.F.A. and in 1936 for his outstanding work in sand research was awarded the Joseph S. Seaman Gold Medal.

Lester B. Knight has established his own business in Chicago which is known as Lester B. Knight & Associates, Consulting Engineers. His business address is 120 So. LaSalle St., Chicago 3.

Mr. Knight has presented many papers before A.F.A. chapters on sand preparation, foundry modernization and good housekeeping.

Charles S. Northen, Jr., has been appointed sales manager, Sloss-Sheffield Steel & Iron Co., Birmingham, Ala.

Howard H. Wilder has resigned his connection with the Vanadium Corp. of America as foundry technician in the Detroit office, and has become connected with Wilson Foundry & Machine Co., Pontiac, Mich., as research metallurgist. He is an active worker on several committees of the A.F.A. Gray Iron Division.

E. F. Hess, metallurgical engineer, Ohio Injector Co., Wadworth, Wis., has severed his connection with that company after many years of service. Mr. Hess has long been active on A.F.A. committees of the Brass and Bronze Division, and at present is a member of the divisional Executive Committee and vice-chairman of the Recommended Practices committee.

E. F. Hess

Lt. John R. Wark, U.S.N.R., formerly associated with Queen City Sand & Supply Co., Buffalo, now is located at Camp Perry, Ohio, where he is engaged in ground training work as Navy instructor of air combat crew men. Since 1943 he has been stationed in England.

Charles S. Reed, Jr., after three years service as Captain in the Army Air Forces Materiel Command, has received his discharge and returned to the Chicago Retort & Fire Brick Co., Chicago, resuming his position as Vice-President and Secretary of that firm.

Roy Frazier has resigned his position as Superintendent for Hansell-Elcock Co., Chicago, and now is associated with Love Bros., Aurora, Ill., in a foundry advisory capacity.

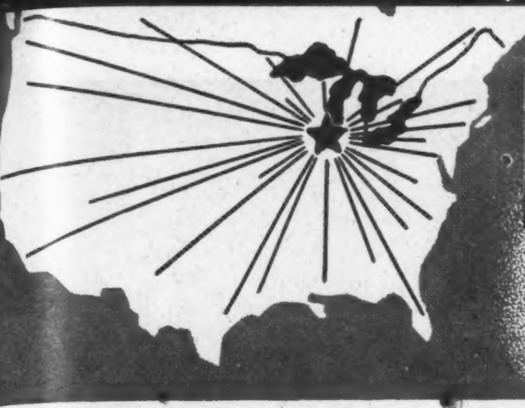
J. Edwin Johnson, member of Chicago Chapter, has been appointed general superintendent of Continental Foundry & Machine, East Chicago, Ind. He was sales engineer until his recent promotion to his present position.

Develops Vertical Type Combustion Furnace

A VERTICAL combustion furnace for the determination of carbon in metals by the direct combustion method, has been patented by W. B. Sobers, of the chemical laboratory of Chain Belt Co., Milwaukee. A unique feature is an elevating, refractory pedestal which carries the sample up into the center of the hot zone of a combustion tube.

Mr. Sobers has contributed several papers for A.F.A. publications. His paper on "A Combined Method of Chemical Analysis for Cast Iron, Malleable Iron and Steel" was presented at the 1944 Annual Meeting in Buffalo. Since 1928 he has been engaged in chemical and metallurgical work with a number of outstanding foundry plants.

The combustion furnace developed by Mr. Sobers is being manufactured by the Hevi Duty Electric Co., Milwaukee.



CHAPTER ACTIVITIES News

NORTHWESTERN PENNSYLVANIA
Added as Chapter Thirty-one

IN MAY, A.F.A. members in the Erie, Pa., territory called an organization meeting and petitioned the A.F.A. Board of Directors for permission to establish a chapter there. The petition was approved and on June 25 at the Moose Club, Erie, Pa., R. E. Kennedy, A.F.A. secretary, announced the formation of the Northwestern Pennsylvania chapter. The "baby" chapter rattle was presented to the thirty-first chapter by Mr. Kennedy.

Fred G. Sefing, International Nickel Co., New York, addressed the membership on heading and gating of castings..

Visitors included Russell F. Lincoln, Russell F. Lincoln & Co., Cleveland, and Gilbert J. Nock, Nock Fire Brick Co., Cleveland, Past Chairman and Secretary, respectively, Northeastern Ohio chapter.

The election of officers and directors took place and these men took office: *Chairman,* Roger W. Griswold, Jr., The Griswold Mfg. Co., Erie; *Vice-Chairman,* Earl M. Strick, Erie Malleable Iron Co., Erie; *Secretary,* H. L. Gebhardt, United Oil Mfg. Co., Erie; *Treasurer,* Ray W. Britton, Urick Foundry Co., Erie; and *Directors,* J. L. Skinner, Skinner Engine Co., Erie; Kenneth T. Guyer, Bucyrus Erie Co., Erie; Lawrence A. Dunn, General Electric Co., Erie; Ralph T. Wedgwood, Pickands Mather & Co., Erie; Roger D. Carver, Standard Stoker Co., Erie; J. S. Hornstein, Meadville Malleable Iron Co., Meadville, and William J. Miller, F. B. Stevens, Inc.; Erie.

Instrumental in forming this new chapter was Chairman Griswold and his co-workers, Kenneth Guyer, Earl Strick, William Miller and Ralph Wedgwood. They comprised the Organization Committee that brought the Erie area foundrymen together for their first meeting in May.

The Northwestern Pennsylvania Chapter becomes the fourth new baby chapter to be added to the ever-growing list of A.F.A. chapters during President Ralph Teetor's term of office. The other "new additions" included Central Ohio, Oregon and Saginaw Valley, recently separated from the Detroit chapter.

All the chapters extend a hearty welcome to the "youngster" and wish it a long and successful life.

Final Meeting Draws Big Crowd at Central New York

By John A. Feola, Crouse-Hinds Co., Syracuse

ONE of the best turnouts of the season attended the annual business meeting of the Central New York chapter June 8. The session was held at Ingersoll-Rand Co., Painted Post, N. Y.

The Ingersoll-Rand Co. acted as host and arranged a very complete afternoon and evening program. A plant visitation was scheduled in the afternoon with the technical meeting in the evening.

The man credited for making this meeting a success was R. A. Minnear, Foundry Superintendent, Ingersoll-Rand Co.

The election of officers took place at this gathering and the following men took office: *Chairman,* E. G. White, Crouse-Hinds Co., Syracuse; *Vice-Chairman,* E. E. Hook, The Dayton Oil Co., Syracuse; *Secretary,* R. A. Minnear, Ingersoll-Rand Co., Painted Post,; *Treasurer,* M. H. Hollenbeck, Kennedy Valve Mfg. Co., Elmira; and *Directors,* N. Paul Benson, Frazer & Jones Co., Syracuse; Arthur Hintz, Rensselaer Valve Co., Troy; and L. E. Hall, Syracuse Chilled Plow Co., Inc., Syracuse.

The technical discussion was presented by Ben F. Shepard, chief metallurgist, Ingersoll-Rand Co. His

subject was "Cast Iron, A New Engineering Material." The informative and lively discussion on the subject was highlighted by the showing of a movie produced in the laboratories of the Ingersoll-Rand Co.

The three men in the above photograph are the new officers of the Saginaw Valley chapter (left to right)—John Smith, vice-chairman, Chevrolet Grey Iron Foundry, Saginaw; H. G. McMurry, chairman, Buick Motor Div., Flint; and M. V. Chamberlin, secretary-treasurer, Dow Chemical Co., Midland.

Klement's Melting Talk Closes Birmingham's Year

By J. P. McClendon, Stockham Pipe Fittings Co., Birmingham

ON MAY 18, the Birmingham chapter, under the leadership of Chairman J. T. Gilbert, Stockham Pipe Fittings Co., closed one of the most successful years in its history. J. F. Klement, assistant chief metallurgist, Ampco Metal, Inc., was the speaker, and his subject, "Melting Mediums for Bronze Alloys," was well received.

Honors of the evening were especially directed to Program Chairman Dr. James T. MacKenzie, American Cast Iron Pipe Co., and Membership Chairman A. S. Holberg, Alabama Clay Products Co.

Dr. MacKenzie was able to present many outstanding and interesting speakers on vital foundry subjects at each of the meetings.

Mr. Holberg and members of his committee including: George F. Vann, American Cast Iron Pipe; Frank Kopp; Dave Rooker; Paul Sullivan, U. S. Pipe & Foundry Co., Bessemer; and Morris L. Hawkins, Stockham Pipe Fittings Co.; really sold the Association to new members.

The election of officers took place at this meeting and are as follows: *Chairman,* J. A. Woody, American Cast Iron Pipe Co.; *Vice-Chairman,* T. H. Benners, Jr., Woodward Iron Co., and *Secretary-Treasurer,* Fred K. Brown, Adams, Rowe & Norman, Inc.

A three-year directorship was awarded to J. T. Gilbert and C. P. Caldwell, Caldwell Foundry & Machine Co. Dr. J. T. MacKenzie and J. F. Wakeland, McWane Cast Iron Pipe Co., were elected to serve as directors for two years and Arthur Lee, Lee Bros. Foundry Co., Anniston, as director for one year.

Chesapeake Chapter Studies Sound Castings Production

By E. J. Hubbard, Koppers Co., Baltimore

PRESENTING an interesting discussion on the use of knock-off risers, step risers and the use of chills, F. G. Sefing, International Nickel Co., New York City, N. Y., concluded the Chesapeake chapter's technical meetings for the current year. Speaking before the membership April 25 at the Engineers' Club, Baltimore, Mr. Sefing gave a thorough presentation of the problem of progressive solidification and adequate venting of cores and molds.

The chapter announced the following men were nominated for officers and directors for the coming year: *Chairman,* H. F. Taylor, Naval Research Laboratory, Anacostia, D. C.; *Vice-Chairman,* David Tamor, American Chain & Cable Co., York, Pa.; *Technical Secretary,* Blake Loring, Naval Research Lab-

The organization meeting held in May at Erie, Pa., for an A.F.A. chapter in that territory was a tremendous success. Left—J. H. Smith, Saginaw Malleable Iron Div., General Motors Corp., Saginaw, Mich., addresses the chapter on motion study. Center—R. E. Kennedy, Secretary, A.F.A., (left) sits with the Organization Committee. The members are (left to right) William J. Miller, Frederic B. Stevens, Inc.; Ralph T. Wedgwood, Pickands Mather & Co.; Chairman R. W. Griswold, Jr., The Griswold Mfg. Co.; Kenneth T. Guyer, Bucyrus Erie Co.; and Earl M. Strick, Erie Malleable Iron Co. Right—Stuart Martin, Saginaw Malleable Iron Div., who aids Mr. Smith in actual motion study demonstration.

The Western Michigan chapter's Membership Committee worked diligently during the past year obtaining new members. Above are shown eighteen new men which represent a portion of the committee's activity.

oratory, Anacostia, D. C.; *Directors,* H. A. Horner, Frick Co., Inc., Waynesboro, Pa.; J. B. Mentzer, Wood Embly Brass Co., Waynesboro, Pa.; and G. L. Webster, Baltimore Polytechnic Institute, Baltimore, Md.

Tait Becomes Chairman Of Eastern Canada Chapter

EASTERN Canada and Newfoundland chapter has voted for its officers and directors who will function for the coming year. Those men asked to fill the important positions are: *Chairman,* G. Ewing Tait, Dominion Engineering Works, Lachine; *Vice-Chairman,* H. Louette, Warden King Ltd., Montreal; *Secretary-Treasurer,* Robt. E. Cameron, Webster & Sons Ltd., Montreal; *Immediate Past President,* R. Bernard, La Cie J. A. Gosselin Ltee, Drummondville; and *Directors,* A. Allard, Arts & Crafts School, Provincial Government, Montreal; Ed. Laurendeau, Canadian Pattern & Wood Working Co., Montreal; James H. Newman, Chamberlain Engineering (Canada) Ltd., Montreal; O. H. Seveigny, Lynn MacLeod Metallurgy Ltd., Thetford Mines; and R. Leclaire, Dominion Engineering Works, Lachine.

Ontario Concludes Year with Meeting and Election

By G. L. White, Westman Publications, Ltd., Toronto

THE annual meeting and entertainment of the Ontario chapter was held at the Royal York Hotel, Toronto, May 11. The installation of officers was made as follows: *Chairman,* T. D. Barnes, Don. Barnes Foundry Supplies & Equip., Hamilton; *Vice-Chairman,* J. A. Wotherspoon, Anthes-Imperial, Ltd., St. Catharines; *Secretary-Treasurer,* G. L. White, Westman Publications Ltd., Toronto; *Directors,* E. G. Storie, Fittings Ltd., Oshawa; J. H. King, Werner G. Smith Ltd., Toronto; H. E. Craddock, Beatty Bros., Ltd., Toronto; D. H. Gilbert, Dominion Wheel & Foundries, St. Boniface, Manitoba; and M. N. Tallman, A. N. Tallman Bronze Co., Ltd., Hamilton

Gold buttons were awarded to all past chairmen of the Ontario chapter following the installation of officers.

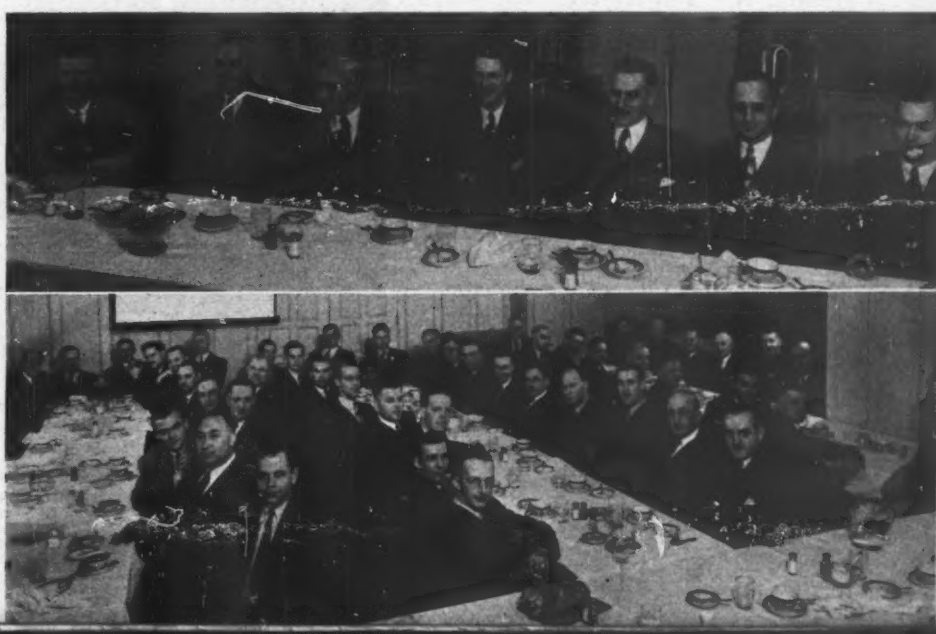
Southern California Obtains Sand Tips From Den Breejen

By J. B. Morey, International Nickel Co., Los Angeles

STRESSING the lower cost angle in modern foundries brought about by more efficient sand reclaiming, Adrian C. Den Breejen, Hydro-Blast Corp., Chicago, presented an unusually interesting talk before the Southern California chapter May 18. The speaker punctuated his advice with colored slides showing sand in various stages of reclamation.

A coffee talk on test bars delivered by Myron B. Niesley, Cali-

The West coast's newest addition, the Oregon chapter, had a good turnout at this their organization meeting. (Below)—The Organizing Committee (left to right) E. G. Huffschmidt, Western Foundry Co.; A. G. Hobson, Western Foundry Co.; R. E. Kennedy, Secretary, A.F.A.; W. R. Pindell, Northwest Stove & Furnace Works, Inc.; Chas. Hoehn, Enterprise Engine & Foundry Co., San Francisco, Past A.F.A. National Director; Nate Weinger; and A. R. Prier, Oregon Brass Works.



fornia Testing Laboratories, instigated a lively discussion on testing techniques.

The election of officers and directors took place during this meeting and the following men assume office: *President,* Robert R. Haley, Advance Aluminum & Brass Co., Los Angeles; *Vice-President,* Wm. D. Emmett, Los Angeles Steel Casting Co., Los Angeles; *Secretary,* Henry E. Russill, Eld Metal Co., Ldt., Los Angeles; *Treasurer,* L. O. Hofstetter, Brumley-Donaldson Co., Los Angeles; and *Directors,* Victor P. Barton, Triplett & Barton, Inc., Los Angeles; Henry W. Howell, Howell Foundry Co., Los Nietos; Chas. R. Gregg, Reliance Regulator Corp., Los Angeles; and J. M. Crawford, Snyder Engineering Corp., Los Angeles.

Detroit Victory Outing Brings Largest Turnout

By H. H. Wilder, Vanadium Corp. of America, Detroit

THE Detroit chapter held its Victory Outing at Forest Lake Country Club, Pontiac, Mich., on June 9. Approximately 425 were in attendance for golf, refreshments, dinner and floor show.

Monk Presents Industrial Relations at Quad City

By H. L. Creps, Frank Foundries Corp., Moline

SPEAKER for the May Quad City chapter meeting was Ralph M. Monk, director of industrial relations, Caterpillar Tractor Co., Peoria, Ill. The meeting was held at the Hotel Fort Armstrong, Rock Island, Ill. Mr. Monk's talk was based on the well known premise that employees can obtain high wages only through increase in production or efficiency. Such topics as management activities, discipline, production control and seniority problems also were discussed.

New chapter officers and directors were elected as follow: *Chairman,* C. E. VonLuhrte, Chicago Retort & Fire Brick Co., Davenport, Iowa; *Vice-Chairman,* C. S. Humphrey, C. S. Humphrey Co., Moline, Ill.; *Secretary-Treasurer,* W. H. Sundeen, Ordnance Steel Foundry Co., Bettendorf, Iowa; *Directors,* R. E. Wilke, Deere & Co., Moline, Ill.; H. L. Creps, Frank Foundries Corp., Moline, Ill.; R. H. Swartz, Ordnance Steel Foundry Co., Bettendorf, Iowa; and A. VanLantschoot, Iowa Malleable Iron Co., Fairfield, Iowa.

Chapter Election Is Held at Toledo Meeting

THE members of the Toledo chapter have voted the following men into office to serve them in 1945-46: *Chairman,* N. P. Mahoney, Maumee Malleable Castings Co., Toledo; *Vice-Chairman,* B. L. Pickett, Unitcast Corp., Toledo; *Secretary-Treasurer,* Gerald Rusk, Freeman Supply Co., Toledo; and *Directors,* W. P. Mack, Bruce Foundry Co., Tecumseh, Mich.; and Leighton Long, Leighton M. Long & Associates, Toledo.

St. Louis May Meeting Concerns Malleable Iron

By C. E. Rothweiler, Hickman, Williams & Co., St. Louis

OUTLINING the methods by which malleable iron can be made; the importance of moisture and carbon control; and heat treatment, H. Bornstein, Deere & Co., Moline, Ill., presented a most informative lecture at the St. Louis district chapter May 10. The speaker, an A.F.A. Past President, spoke on "Malleable and Pearlitic Malleable Castings."

New officers and directors were elected at this meeting and include the following men: *Chairman,* Walter E. Illig, Banner Iron Works; *Vice-Chairman,* Roland T. Leisk, American Steel Foundries, East St. Louis, Ill.; *Secretary-Treasurer,* Lee H. Horneyer, The Sheffield Corp.;

(Continued on Page 92)

From the Eastern Canada and Newfoundland chapter come these pictures taken at their regional conference dinner.

Abstracts

NOTE: The following references to articles dealing with the many phases of the foundry industry, have been prepared by the staff of *American Foundryman*, from current technical and trade publications.

When copies of the complete articles are desired, photostat copies may be obtained from the Engineering Societies Library, 29 W. 39th St., New York, N. Y.

Aluminum-Base Alloys

INGOT VS. SCRAP. *(See Ingot Metal.)*

MELTING AND POURING. *(See Magnesium-Base Alloys.)*

RECLAMATION. Rathbone, A. H., *"The Reclamation of Aluminum Alloys in an Aero-engine Foundry,"* FOUNDRY TRADE JOURNAL, April 12, 1945, vol. 75, no. 1495, pp. 299-302; April 19, 1945, vol. 75, no. 1496, pp. 315-318.

Because of the need for aluminum created by the war, the Rolls Royce foundry installed furnaces for the reclamation of aluminum-base alloys. Three types of metal or metal-bearing materials were handled: contaminated scrap, swarf and turnings, and foundry residues, skimmings, flash from fettlings, etc.

Contaminated scrap was melted under reducing conditions in a reverberatory furnace. Metal was drained from the furnace as it melted and the temperature was maintained high enough to melt the aluminum but not high enough to melt bronze or steel inserts which might be in the scrap. The molten metal was allowed to stand for a sufficient length of time to eliminate most of the dissolved gases and for oxides to separate.

Swarf was dried, screened for size, magnetically separated from iron and steel pieces, and then melted under a flux in a rotary converter type of furnace. Some of the swarf was briquetted before melting.

The residues and skimmings were melted in a tilting-type crucible furnace with a flux.

Analyses of the melts were determined spectrographically, using techniques described by the author.

SALVAGE. *"Salvaging Aluminum Castings,"* MODERN METALS, May, 1945, vol. 1, no. 4, pp. 13-15.

Under certain conditions the salvaging of aluminum-base castings is desirable. This may be done by four methods: welding, impregnation, peening, and blending. The procedure for carrying out each salvage process is described, including any auxiliary treatment or cleaning necessary.

Following the salvage of a casting, it should be inspected to determine whether the salvage treatment has been effective. The authors discuss the requirements of visual examination, pressure testing, X-ray examination, chalk testing, and etching.

Bearings

MATERIALS. Holligan, P. T., *"Bearing Developments,"* FOUNDRY TRADE JOURNAL, May 3, 1945, vol. 76, no. 1498, pp. 3-9.

A comparison of the advantages and disadvantages of various types of materials for bearing shells and linings. The author traces the development of bearings from the original gun metal bearings through leaded gunmetals, lead bronzes, graphitic cast-iron shafts, steel shells, copper-lead linings, sintered copper lead and lead bronze, and trimetal bearings. Emphasis is placed on the suitability of the materials for bearing applications and little is said about foundry problems.

Bronze

ALUMINUM AND MANGANESE. *(See Copper-Base Alloys.)*

Casting Methods

PERMANENT MOLD. *(See Permanent Mold Castings.)*

VACUUM CASTING. Rose, Kenneth, *"Vacuum Casting of Electronic Parts,"* METALS AND ALLOYS, May, 1945, vol. 21, no. 5, pp. 1324-1326.

Metal parts for inclusion in vacuum tubes must be cast in such a way as to exclude gases. The copper anode for X-ray tubes is such a part.

The author describes a method of melting and casting copper in an evacuated glass furnace heated by an induction coil surrounding the furnace. The copper is melted in a graphite cylinder which serves as both the mold and the crucible. The metal is cast about a tungsten insert which is held in position by means of tungsten wires.

By having a number of glass furnaces and shifting the heating coil from one to another, the process can be made almost continuous.

Chemical Analysis

BRASS. Pollak, F. F. and Pellowe, F., *"Chemical Control,"* METAL INDUSTRY, April 6, 1945, vol. 66, no. 14, pp. 210-212; April 13, 1945, vol. 66, no. 15, pp. 231-233.

Since the war the supply of virgin metal has been insufficient, and all-swarf melts have been used to produce a high-quality brass. In order to do this successfully, careful control of the analysis must be maintained.

The major part of this article is devoted to the analytical methods used to determine copper, lead, iron, tin, aluminum, antimony, manganese, arsenic, nickel, phosphorus, and zinc.

Clays

PROPERTIES. Grim, R. E., and Cuthbert, F. L., *"Some Clay-Water Properties of Certain Clay Minerals,"* THE JOURNAL OF THE AMERICAN CERAMIC SOCIETY, March 1, 1945, vol. 28, no. 3, pp. 90-95.

Computed values are given for the thickness of the water film absorbed on the surfaces of the various clay minerals when clays composed of such minerals develop specific plastic characteristics. Based on such values, the following concept of clay-water relationships is presented. The dominant factor determining the plastic properties of clays is the rigidity of the water held on the surfaces of the clay minerals, and the point of beginning of the transition of completely rigid water to liquid water is marked by great changes in such properties. Each type of clay mineral seems to have a characteristic ability to stabilize water, and the exchangeable ions also exert an influence. The reaction between water and kaolinite or halloysite, may require considerable time so that there is frequently a time lag after mixing clays composed of such minerals before the plastic properties are fully developed.

Applications of the foregoing concept in the fields of geology, ceramics, and soil mechanics are suggested.

Copper-Base Alloys

BEARING METALS. *(See Bearings.)*

BERYLLIUM COPPER. Yarham, E. R., *"Beryllium Copper, A Review of Its Properties,"* THE IRON AGE, April 26, 1945, vol. 155, no. 17, pp. 63-67.

Most of this article is devoted to the mechanical and physical properties of rolled and worked alloys. However, the last part of the article describes the foundry practice and alloying procedure used in the making of green sand castings.

The article contains tables which give the physical properties of two beryllium-nickel-copper alloys. The properties obtained on specimens cut from heat treated test bars cast in green sand.

BRONZES. Akerman, L. H., *"Orthodox and Unorthodox Technique Applicable to Aluminum and Manganese Bronze,"* FOUNDRY TRADE JOURNAL, April 26, 1946, vol. 75, no. 1497, p. 346.

A brief review of some of the principles of gating, heading, and coring molds for aluminum bronze and manganese bronze castings.

DEOXIDATION EFFECTS. Pell-Walpole, W. T., *"The Effect of Deoxidation Procedure on the Properties of Chill-Cast Tin Bronze Melted Under an Oxidizing Flux,"* THE JOURNAL OF THE INSTITUTE OF METALS, London, 1945, vol. 71, pp. 37-44.

The deoxidation of tin bronze melted under an oxidizing flux has been studied. Additions of phosphorus or aluminum or both were made before or after removing the flux from the molten metal.

Deoxidation with phosphorus is fully

effective, giving maximum density and mechanical properties, irrespective of the stage in the melting at which the addition is made, provided sufficient is added to insure a residual content of about 0.02 per cent in the bronze. If the phosphorus is added before removing the flux, a considerable proportion is absorbed by the latter.

Deoxidation with aluminum gives higher densities than phosphorus does, but inferior mechanical properties owing to entrapped oxide films. These occur most extensively in ingots deoxidized after removal of the oxidizing flux. The use of phosphorus together with aluminum does not eliminate the disadvantages of the latter and leads to no improvement in properties.

INGOT VS. SCRAP. *(See Ingot Metal.)*

POROSITY. McIntyre, J. B., *"Copper Castings,"* METAL INDUSTRY, March 23, 1945, vol. 66, no. 12, pp. 178-179.

The author analyzes the causes of porosity in copper castings, shows that the presence of oxygen is not invariably the cause as is popularly believed, and suggests a procedure to reduce porosity troubles to a minimum.

Core Making

DEPARTMENT LAYOUT. *"Core Making,"* STEEL, April 30, 1945, vol. 116, no. 18, p. 116.

Layout of the core making department at the Pittsburgh Valve & Fittings Co., Barberton, Ohio. The layout is centered about a three-zone automatic double conveyor, in such a way as to speed up all operations and greatly reduce the amount of handling necessary.

Core Ovens

GAS. *(See Fuels.)*

Core Sands

INHIBITORS. *(See Magnesium - Base Alloys.)*

Cores

CORE PRINTS. *"A Foundryman's Notebook, II Positioning and Securing Cores,"* Scribe, IRON AND STEEL, March 1945, vol. 18, no. 3, p. 81.

Methods of positioning and securing various types of cores.

Costs

COST SYSTEMS. Holladay, H. E. E., *"Costs in a Jobbing Foundry,"* FOUNDRY TRADE JOURNAL, May 10, 1945, vol. 76, no. 1499, pp. 25-30.

The author's account of his experiences in revising the cost systems in foundries producing various classes of castings.

Die Castings

DIE DESIGN. *"Stronger Die Castings,"* STEEL, March 26, 1945, vol. 116, no. 13, pp. 94-95, 128, 130.

Changes in die designs can bring about vast improvements in the properties of zinc-base castings made in the dies.

METHODS. Nagle, H. E., *"Making Die Castings,"* STEEL, April 23, 1945, vol. 116, no. 17, pp. 92-96, 138.

Applications of die castings to lock parts, designing and machining dies, and alloys used for die casting.

Education

FOUNDRY TRAINING. *"Bringing School to the Foundry,"* John M. Hagan, ALUMINUM AND MAGNESIUM, February, 1945, vol. 1, no. 5, pp. 22-23, 26-27.

The author describes a successful foundry school established to train men and women to replace the trained labor lost to the draft. The training program was set up in cooperation with the Illinois State Department of Vocational Education and the National Defense Program.

Electric Furnaces

ELECTRODE CONTROL. *(See Furnaces.)*

INDUCTION. *(See Furnaces.)*

Fabrication

METHODS. *"Production Processes and Methods,"* PRODUCT ENGINEERING, April, 1945, vol. 16, no. 4, 16-page insert.

A review of various production processes, their characteristics, and their influence upon the design of products and machines.

The casting methods described include sand casting, permanent mold casting, centrifugal casting, precision casting, and die casting.

Fuel

ECONOMY. *"Foundry Fuel, the Heat Balance as an Aid to Economy and Efficiency."* W. J. Driscoll, IRON AND STEEL, March, 1945, vol. 18, no. 3, pp. 75-80.

A demonstration of the way which an analysis of the foundry fuel input and the manner in which heat is expended, properly interpreted, can indicate fuel savings.

Fuels

GASES. Haynes, Harold, *"Uses of Gases in the Foundry,"* FOUNDRY TRADE JOURNAL, March 15, 1945, vol. 75, no. 1491, pp. 209-213.

The author discusses the advantages of using town's gas or producer gas for surface drying molds, drying ovens, ladle drying, and kindling cupolas.

Furnaces

ELECTRIC. *"Arc Furnace Regulations,"* R. A. Geiselman and J. E. Reilly, STEEL, March 19, 1945, vol. 116, no. 12, pp. 136, 139, 170, 172.

Electronic regulation of electrode motors, in conjunction with generator voltage control, makes possible a controlled range of hoisting speed with reduced breakage of electrodes.

INDUCTION. *"Induction Heating,"* Frank T. Chesnut, THE IRON AGE, March 22, 1945, vol. 155, no. 12, pp. 46-53.

A history of the development and the industrial applications of induction heating, from the initial work done by Dr. Edwin F. Northrup in 1916 to the present day. The author closes the article with a discussion of the future possibilities for induction heating.

Gating and Risering

ALUMINUM BRONZE. *(See Copper-Base Alloys.)*

MANGANESE BRONZE. *(See Copper-Base Alloys.)*

PRINCIPLES. Nisbet, J. G., *"The Basic Principles in the Feeding of Castings,"* FOUNDRY TRADE JOURNAL, April 12, 1945, vol. 75, no. 1495, pp. 293-297; April 19, 1945, vol. 75, no. 1496, pp. 319-322.

The author compares standard methods of running and heading various types of castings with his preferred methods.

WHIRL GATES. *"'Whirl-Gate' and 'Atmospheric' Heads,"* CANADIAN METALS AND METALLURGICAL INDUSTRIES, May, 1945, vol. 8, no. 5, pp. 33-35.

This article is reproduced from the *"First Report of the Foundry Practice Sub-Committee"* of the Steel Castings Research Committee of the Iron and Steel Institute and the British Iron and Steel Federation.

The article discusses the development of whirl gates, starting with a spinning or whirling ingate designed to keep dirt from entering molds. The next step in the development was the application of a whirl gate to the ordinary L-head. Later on heads with restricted openings were placed so close to the casting that the sand between was heated and enabled the head to successfully feed the casting. The latest development was the combination of the whirl gate and the restricted opening head.

Along with the article is a table showing the results of casting 6-inch cubes using various types of heads.

Graphitization

INOCULANTS. *(See Gray Cast Iron.)*

Gray Cast Iron

APPLICATIONS. Berdoll, J. G., *"Casting and Machining Iron Crankshafts,"* METALS AND ALLOYS, April, 1945, vol. 21, no. 4, pp. 994-999.

A pictorial record of the casting operations performed in the manufacture of cast iron crankshafts for compressors and similar equipment.

INOCULANTS. *"Inoculants in Gray Iron,"* Rebecca Hall Smith, THE IRON AGE, March 15, 1945, vol. 155, no. 11, pp. 58-62.

After defining an inoculent as a material added to gray iron to control graphization, the author discusses theories of inoculation, types of inoculants, chill tests, and the amounts, methods of adding, and effects of inoculants.

MACHINE-TOOL CASTINGS. Ritchie, J. G., *"Metallurgical Aspects of Machine-Tool Castings,"* FOUNDRY TRADE JOURNAL, March 22, 1945, vol. 75, no. 1492, pp. 231-234; March 29, 1945, vol. 75, no. 1493, pp. 251-255.

The author describes the structure of gray cast iron; the effect of section, total carbon, and silicon; melting practice; damping capacity; specifications and testing; wear resistance; hardening and tempering; and stress relieving.

The article includes a table which shows that the hardness of gray cast iron increases with the combined carbon content in the same way that the hardness of a steel increases with carbon. Another table gives the graphitizing value of a number of alloying elements, indicating how it is possible to balance the cementite stabilizing and graphitizing elements in gray cast iron.

Hardness

MECHANICAL PROPERTY RELATIONSHIPS. Gray, T. H., *"Relation Between Hardness and Other Mechanical Properties,"* PRODUCT ENGINEERING, April, 1945, vol. 16, no. 4, pp. 236-240.

Hardness tests are now much used to indicate other mechanical properties. The author discusses the relationship between hardness and other mechanical

(Abstracts continued to page 98)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CHAPTER ACTIVITIES

(Continued from Page 82)

Directors, E. Eugene Ballard, National Bearing Div.; J. H. Bodine, Bodine Pattern & Foundry Co.; Ralph M. Hill, Jr., East St. Louis Castings Co.; and Herman Weible, Maco Foundry & Enamel Shop.

Time Study Demonstration As Western Michigan Meet

By C. H. Cousineau, Western Michigan Steel Foundry Co., Muskegon

THE use of an actual demonstration in the application of time and motion study was the highlight of the talk given by James H. Smith, Saginaw Malleable Iron Div., General Motors Corp., Saginaw, Mich., at Western Michigan's April 9 meeting.

With the assistance of Stuart D. Martin, Saginaw Malleable Iron Div., Mr. Smith showed an old method of core making and how time and motion study could improve the method. This talk and demonstration was greatly appreciated by all those present.

Industrial Radiography Report at Minneapolis

By H. F. Scobie, University of Minnesota, Minneapolis

A F. COTA, A. O. Smith Corp., Milwaukee, spoke on "Industrial Radiography" to the members and guests present at the Twin City chapter's May 23 meeting. Mr. Cota traced the growth of radiography and explained the general principles involved in making and processing a radiograph. The speaker showed a number of slides illustrating radiographic technique in the laboratory, shop and field. The need for protection of personnel from high voltage and stray radiation was stressed.

The gathering was presided over by the new Chapter Chairman R. C. Wood, Minneapolis Electric Steel Castings Co., Minneapolis. A. M. Fulton, Northern Malleable Iron Co., St. Paul, retiring chairman, thanked the chapter for its cooperation and cited Sheldon Pufahl, Paul Pufahl & Sons Foundry Co., Minneapolis, Membership Committee Chairman, for his good work.

(Continued on Page 94)


THE SAW WITH
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The popularity of this new Saw Band spread like wildfire through airplane, jeep and motor plants, shipyards, large and small parts factories. Because of it, designers and engineers specify more and more of the new light metals, laminates, plastics and plywoods — metal saw operators double and triple their output.
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CHAPTER ACTIVITIES

(Continued from Page 92)

Janco Explains Centrifugal Casting to N.E.F.A. Men

By Merton A. Hosmer, New England Foundrymen's Assn., Boston

EXPLAINING in detail the two methods of centrifugal casting: vertical and horizontal, Nathan Janco, Centrifugal Casting Co., Tulsa, Okla., made the recent meeting of the New England Foundrymen's Association a big success. Mr. Janco has long been a proponent of making castings centrifugally and showed a thorough knowledge of this method. His experience as consulting engineer in this connection to a large number of foundries was eminent in his talk. His opinions on directional solidification and types of molds that can be used in this process was very interesting.

Philadelphia Lectures Bring Large Attendance

By B. A. Miller, The Baldwin Locomotive Works, Philadelphia

OVER 300 students, comprising molders, coremakers, apprentices and foundry executives, are attending the weekly lecture courses sponsored by the Philadelphia chapter at the University of Pennsylvania. From the enthusiasm shown, as well as the questions asked, it is very evident that the course is proving very successful.

It is the aim of this chapter to continue advanced courses in the succeeding year, with the thought in mind of developing foundry supervisors and technicians.

Sefing Tells Molding Methods at Cent. N. Y.

By John Feola, Crouse-Hinds Co., Syracuse

THE Central New York chapter members were privileged to hear Fred G. Sefing, International Nickel Co., New York City, N. Y., when they assembled at the Onondaga Hotel, Syracuse, May 14.

Mr. Sefing, who used as his subject, "A Study of Molding Methods

(Concluded on Page 96)


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CHAPTER ACTIVITIES

(Continued from Page 94)

for Sound Castings," presented the subject so members could ask questions as he discussed various methods.

The speaker stressed the point that a sound casting is the cheapest for a customer, and the foundry that has a reputation for producing sound castings could ask a higher price than one which had a large percentage of rejects.

Pattern Cooperation Need Is Stressed at Rochester

By C. B. Johnson,
Symington-Gould Corp., Rochester

THE great need for cooperation between the patternmaker and the foundry was emphasized at the Rochester chapter when it met recently at the Hotel Seneca to hear L. F. Tucker, City Pattern Works, South Bend, Ind.

Mr. Tucker illustrated the importance of close collaboration between engineer, patternmaker and molder by saying that no matter how exact a pattern may be constructed in harmony with the drawing, the pattern is not constructed correctly until it has produced an acceptable salable casting. He also pointed out the great importance of keeping in mind the molder's problems when constructing a pattern.

Birmingham Learns About Casting Metals in Plaster

By J. P. McClendon,
Stockham Pipe Fittings Co., Birmingham

EXTENDING the possibility of, and showing samples of, precision castings made from cement molds, E. H. Schleede, development engineer, U. S. Gypsum Co., Chicago, presented an informative lecture, "Patterns of Gypsum Cement," to Birmingham foundrymen at their April meeting.

August Chapter Meetings

August 4
Southern California
Lakewood Country Club
North Long Beach
ANNUAL STAG PARTY

August 18
Western Michigan
Spring Lake Country Club
Grand Haven, Mich.
ANNUAL OUTING

ABSTRACTS

(Continued from page 84)

properties for various alloys. He gives empirical equations and graphs for determining the other properties, such as tensile strength, wear resistance, machinability, fatigue strength, and toughness.

Also included in the article is a hardness conversion chart for hardened steels.

Heat Resistant Alloys

CAST AND WROUGHT ALLOYS. *"Materials and Methods Manual 4,"* Oscar E. Harder, METALS AND ALLOYS, March, 1945, vol. 21, no. 3, pp. 725-736.

One of a series of manuals on engineering materials and production methods, intended to present reference data on the characteristics of and processes used with high-temperature service alloys.

Heat Treatment

STEEL. Dube, Arthur and S. L. Gertsman, *"Heat Treatment of Steel,"* CANADIAN METALS AND METALLURGICAL INDUSTRIES, April, 1945, vol. 8, no. 4, pp. 20-27.

A presentation of the modern ideas of heat treatment derived from metallurgical studies. The authors have discussed austenitizing, austenite transformation, normalizing, full annealing, isothermal annealing and spheroidizing, hardening, retained austenite, and internal stresses.

SUB-ZERO. Amtsberg, H. C., *"Sub-Zero Treatment of Steels,"* CANADIAN METALS AND METALLURGICAL INDUSTRIES, April, 1945, vol. 8, no. 4, pp. 33-36.

A correlation of the fundamentals of cooling hardened steels to temperatures considerably below room temperature with the basis treatment cycle and related structural changes.

The article contains time-temperature transformation curves for 18-4-1 high speed steel and 5 per cent Cr air-hardening steel, curves showing the effect of cyclic treatment on the bend strength of a 1 per cent C, 5 per cent Cr, 1 per cent Mo air-hardening steel, and curves representing the heat treating cycles for high-speed and tool steels. A short bibliography on heat treatment of steel follows the article.

High Temperature Service

GRAPHITIZATION. *(See Steel.)*

Ingot Metal

INGOT VS. SCRAP. Beard, George F., *"Advantages of Ingot Metal,"* CANADIAN METALS AND METALLURGICAL INDUSTRIES, April, 1945, vol. 8, no. 4, pp. 28-32.

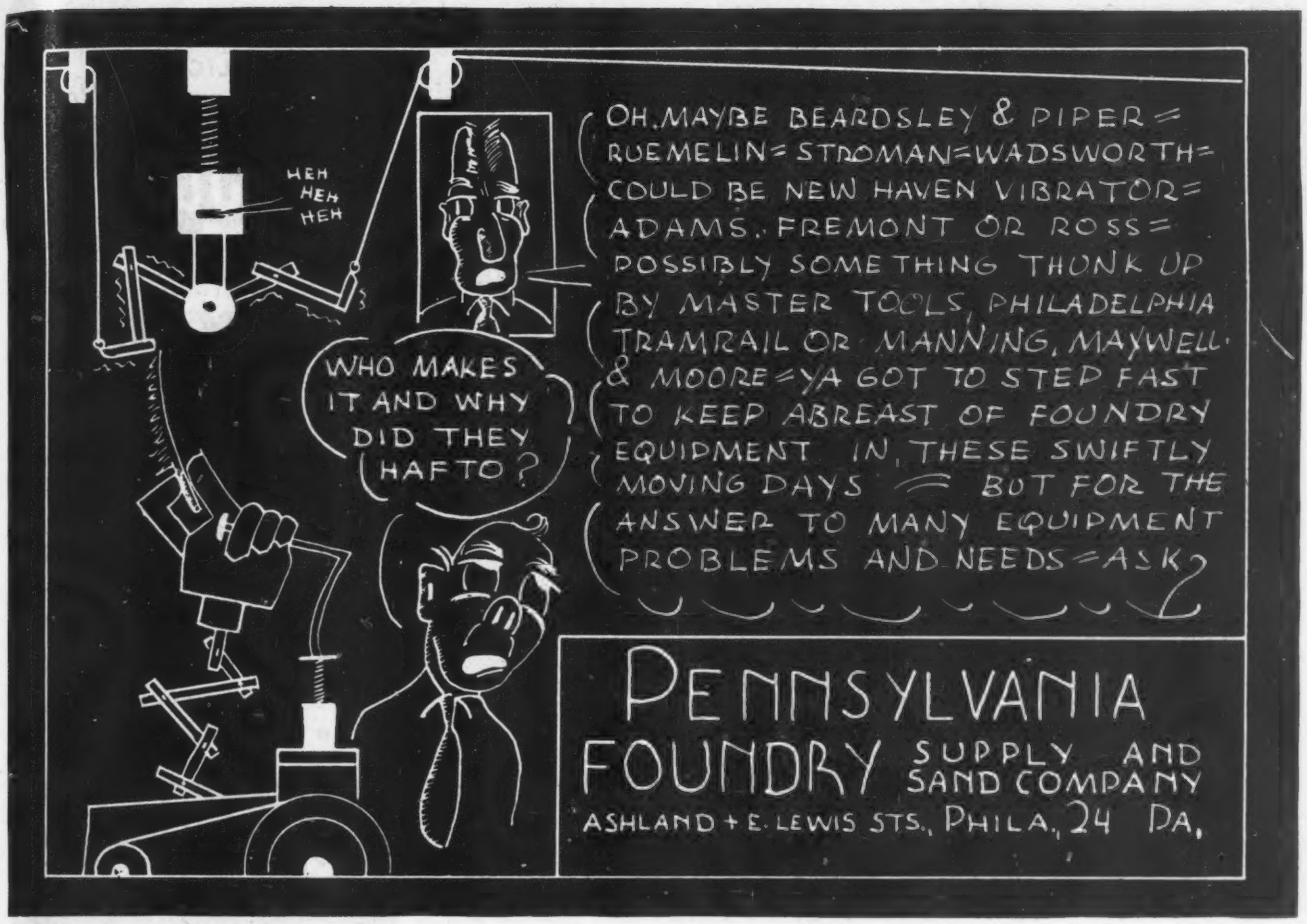
When many alloys are produced within one foundry, the danger of contaminating metal by remelting gates and risers, runners, and similar scrap is very great. The use of ingot metal which has been carefully refined and chemically analyzed will eliminate many of the difficulties which attend the practice of remelting foundry scrap.

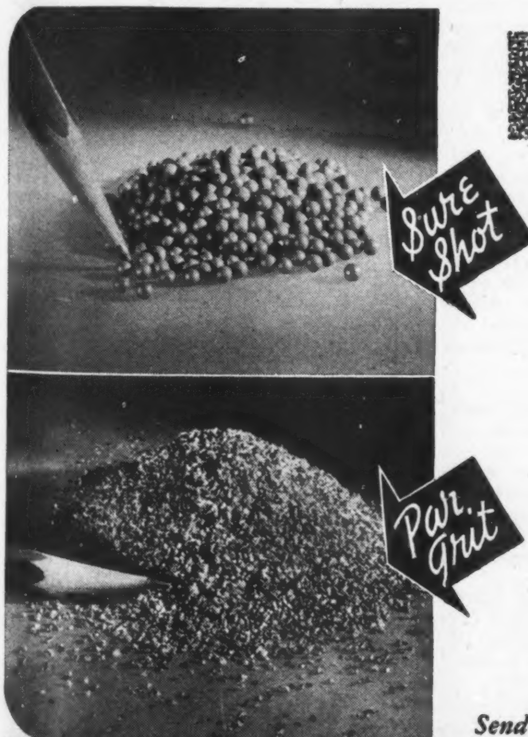
The author has described the effects upon copper-base and aluminum-base alloys of the most common contaminating metals which may be picked up through remelting.

Ladles

NOZZLES. *"New Type Ladle Nozzle Affords Uniform Pouring Speed,"* STEEL,

(Abstracts continued to page 100)





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ABSTRACTS

(Continued from page 98)

April 16, 1945, vol. 116, no. 16, p. 130.

A description of a multinozzle box arrangement by means of which uniform pouring may be achieved as the head of molten metal within the ladle is lowered.

Magnesium-Base Alloys

FOUNDRY PRACTICE. *"Magnesium Alloy Castings,"* G. L. White, CANADIAN METALS AND METALLURGICAL INDUSTRIES, March, 1945, vol. 8, no. 3, pp. 20-46.

A description of the foundry practices used by the foundry of Light Alloys, Ltd.

INHIBITORS. *"Baked Magnesium Sand Molds Inhibited with Potassium Fluoborate,"* G. H. Curtis, THE IRON AGE, February 22, 1945, vol. 155, no. 8, pp. 54-61.

Potassium fluoborate may be used as an inhibitor in magnesium sands. Since it melts and decomposes at a higher temperature than do most inhibitors, molds and cores made with potassium fluoborate may be baked at higher temperatures without loss of the inhibitor. The author discusses the effect of potassium fluoborate on the properties of sands at elevated temperatures.

INHIBITORS. *"Oxidation Inhibitors in Core-sand Mixtures for Magnesium Castings,"* O. Jay Myers, A.I.M.E. Technical Publication No. 1776, METALS TECHNOLOGY, February, 1945, vol. 12, no. 2, 9 pp.

Inhibitors to prevent the oxidation of magnesium-base alloys may be used with sand cores and dry sand molds in two ways—they may be sprayed on the surface or they may be incorporated in the sand mixtures. Fluoride salts are generally applied in form of sprays, while boric acid and sulphur are generally incorporated in the sand mix.

The author performed a series of experiments, using each inhibitor in varying amounts and in combination with other inhibitors, and observing the effects of these inhibitors on the properties of the sand mixtures and on the condition of castings produced in molds in which the inhibitors were employed. His experience indicated that there is an optimum combination of inhibitors which reduces burning to a minimum and retains the best combination of sand properties.

MELTING AND POURING. McIntosh, Alexander, *"Melting and Pouring for Magnesium and Aluminum Alloys,"* ALUMINUM AND MAGNESIUM, April, 1945, vol. 1, no. 7, pp. 16-19, 33-34.

The author has carefully described the melting and pouring practices for both magnesium and aluminum-base alloy castings.

In the case of magnesium-base alloys, all procedures are determined and carried out with a view to restraining the extreme reactivity of magnesium as much as possible. Crucibles are carefully inspected to detect cracks before molten metal has a chance to leak through. Furnaces are lined with non-porous low-silica refractories and care is taken to lay the bricks in such a way that molten metal will not come in contact with silica material at the joints. The metal is kept under a flux at all times except during pouring, when a dusting of sulphur and boric acid is used to prevent oxidation.

Precautions in the melting and pour-

ing of aluminum need not be quite so rigid. However, the principal efforts are still directed toward securing a casting free from dross.

METALLOGRAPHY. *"Grain Size and Properties of Sand-cast Magnesium Alloys,"* R. S. Busk and C. W. Phillips, A.I.M.E. Technical Publication No. 1771, METALS TECHNOLOGY, February, 1945, vol. 12, no. 2, 11 pp.

Data giving the relationship between grain size and mechanical properties and on the combined effects of grain size and microporosity in sand-cast magnesium-base alloys are given by the authors. They also discuss the factors which influence the grain size of sand castings.

SUPERHEATING. Fox, F. A. and Lardner, E., *"An Exploration of the Problem of Superheating in Magnesium-Base Alloys,"* THE JOURNAL OF THE INSTITUTE OF METALS, London, 1945, vol. 71, pp. 1-22.

Observations were made concerning the superheating of magnesium alloys. It is shown that the grain-refining effect is confined to alloys containing aluminum, and that tendencies to grain-coarsening are introduced if the superheating time is too long or the temperature too high. Data are given relating tensile properties to grain-size in various aluminum-containing alloys.

It is also shown that the microstructures of superheated alloys differ characteristically from those of the unsuperheated material, and that this difference persists even after solution treatment, the unsuperheated alloy giving a mixed grain-size. Grain sizes are recorded for an alloy, superheated and unsuperheated, cast as rods of various cross-sections. It is shown that stirring just before casting does not eliminate the grain-refinement effect of the superheating.

A discussion of the results follows, and some observations on possible theories of grain refinement are made.

Permanent Mold Castings

METHODS. Sugar, Alfred, *"Permanent Mold Castings,"* Materials & Methods Manual 5, METALS AND ALLOYS, April, 1945, vol. 21, no. 4, pp. 1015-1028.

A review of the application and design features, materials used, mold design and construction, and production operations for permanent mold castings.

In addition to many illustrations, the article contains a tabular comparison of relative design characteristics of different casting methods; a table of commercial tolerances of permanent mold castings; and a table presenting the typical properties of some light metal permanent mold casting alloys.

Steel

GRAPHITIZATION. *"Graphitization of Low-Carbon and Low-Carbon-Molybdenum Steel,"* H. J. Kerr and F. Eberle, STEEL, March 19, 1945, vol. 116, no. 12, pp. 118, 120, 160, 162, 164.

Studies of the tendencies of various steels to graphitize in service at high temperatures have led the authors to recommend that coarse-grained normal carbon-molybdenum steel with an addition of 0.4 to 0.6 per cent chromium be used for high temperature steam plant applications because of the greater stability of the carbide phase in these normal steels as compared to similar steels showing abnormality on the McQuaid Ehn test.

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